EGYPTIAN ASTRONOMICAL TEXTS

II. The Ramesside Star Clocks

by
O. NEUGEBAUER
and
RICHARD A. PARKER

BROWN EGYPTOLOGICAL STUDIES V

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BROWN UNIVERSITY BICENTENNIAL PUBLICATIONS
Studies in the Fields of General Scholarship

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PRESENTED By
SHRI BALKRISHNA

BROWN UNIVERSITY PRESS
PROVIDENCE, RHODE ISLAND
LUND HUMPHRIES
LONDON
1964

LIBRARY OF CONGRESS CATALOGUE CARD NUMBER: 60-15723

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MADE AND PRINTED IN GREAT BRITAIN BY
PERCY LUND, HUMPHRIES AND COMPANY LIMITED
LONDON AND BRADFORD (ENGLAND)
1964

PREFACE

In the first volume we dealt with a group of texts concerned with stars and constellations customarily denoted as decans. On the basis of these texts, which belong to the millennium from the twenty-second to the twelfth century B.C., we tried to reconstruct the early history of the decans in their use as indicators of the hours of the night throughout the year, at first by their risings and later by their transits.

The present volume covers a much shorter period than the first. We shall deal here exclusively with ceilings from royal tombs of the Ramesside period (Ramses VI, VII, and IX, 12th cent. B.C.) and center our discussion on the star tables which measure hours by means of transits, no longer, be it noted, in decades but in half-month intervals.

The third and final volume of this series will deal with all other aspects of the ceilings of the star clocks and all remaining astronomical monuments from the ceiling of Senmut down through the latest period when Hellenistic astronomy introduced the zodiac into Egypt.

It is our pleasure to acknowledge once again our indebtedness to those who have so ably and willingly assisted us in the preparation of this volume. Besides extending our thanks to Miss Natacha Rambova, who kindly supplied us with photographs of the ceiling of Hall E of the tomb of Ramses VI, to Dr. Caroline Peck, who helped with the preparation of the plates, and to Gladys B. Parker, who prepared the manuscript, we must single out for special mention Dr. Charles F. Nims, of the Oriental Institute, whose photographic skill was exercised long and laboriously in the Valley of the Kings so that the photographic plates might reproduce the least vestige of an ancient hieroglyph. Our thanks go also to Dr. T. George Allen to whose kindness we owe a number of the additions and corrections to Volume I which are given on p. 77. Finally, we gratefully acknowledge that the publication costs of this volume have been borne by the National Science Foundation.

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Providence, Rhode Island
1 November 1962

CONTENTS

Introduction ix

Chapter I. THE SOURCES AND THEORY OF THE RAMESSIDE STAR CLOCKS

A. The Sources 1

B. The Hour Stars and the Decans 3

C. Concordance of the Hour Stars 5

D. General Commentary to the Tables 7

E. Approximate Date of the Construction of the Tables 9

F. Astronomical Considerations 9

G. Explanation of Tabular Diagrams 15

Chapter II. THE TEXTS OF THE TABLES 20

Chapter III. CONCLUDING REMARKS 70

List of Abbreviations 75

Subject Index 76

Additions and Corrections to Volume I 77

Notes to the Photographs 78

Plates 1 to 67

INTRODUCTION

The star clocks which are represented in the tombs of Ramses VI, VII, and IX consist of twenty-four tables for the twenty-four half-month intervals of one year. Each table is associated with the representation of a seated man (henceforth called the target figure) and a network of nine equidistant vertical lines which are intersected by thirteen horizontal lines (henceforth called the chart). The horizontal lines represent the beginning of night and the ends of the twelve consecutive hours of night; an accompanying text lists for each of these hours a star from a constellation in relation to the target figure. The star indicates the corresponding hour by its crossing of one of the seven inner vertical lines above the target figure.[1]

A star on the middle vertical line (henceforth denoted by 0) is termed *r ʿḳꜣ ib*, "opposite the heart"; one on the first vertical to the left (−1) or right (+1)[2] is *ḥr irt wnmy*, "on the right eye", or *ḥr irt iꜣby*, "on the left eye"; one on the second vertical to the left (−2) or right (+2) is *ḥr msḏr wnmy*, "on the right ear", or *ḥr msḏr iꜣby*, "on the left ear"; one on the third vertical to left (−3) or right (+3) is *ḥr ḳʿḥ wnmy*, "on the right shoulder", or *ḥr ḳʿḥ iꜣby* "on the left shoulder", respectively.[3]

It is reasonable to assume that the middle line represents the meridian and the other lines circles of altitude at varying distances before or after the meridian, all as seen in the southern sky as it appears to an observer posted to the north of the target figure.

This rather obvious explanation of texts and drawings has been obscured, at first by Champollion's hypothesis of astrological significance of these texts (obviously on the basis of the much later Greek doctrine of the "melothesia"),[4] later by Lepsius' suggestion that a relationship might exist between the seven coordinate lines and the seven climata,[5] and then by the equally unfounded hypothesis that the stars represent the hours by their risings (so Gensler in 1872).[6] Only in 1874 did Le Page Renouf take the coordinate net seriously, give the proper explanation of the procedure (though he took the tables as a calendar of astronomical observations and not as a star clock) and correctly establish the date for which it was originally designed as about 1450 B.C.[7] Le Page Renouf's brilliant paper was apparently overlooked for a long while. Brugsch in his *Thesaurus* (1883) still followed Gensler. In 1891 Bilfinger[8] tried to disprove Renouf's approach and return to the hypothesis of risings in order to obtain a more even distribution in the length of the resulting hours—at the price of declaring both star charts and target figures as meaningless additions to the texts. Finally, Schack-Schackenburg in 1894 rediscovered the significance of the transit lines.[9] Five years

[1] Some of the charts place some stars in the space before or after the proper vertical.

[2] Left (−) and right (+) are from the standpoint of the observer, and the direct reverse of the "left" and "right" applied to the target figure; in other words the *right* side of the target is to the observer's *left*. See also Fig. 3, p. 8.

[3] Instead of *ḥr* the preposition *r*, "at", is used at times and some texts omit any preposition. In either case the reference is to the position of the vertical lines on the target figure.

[4] *Lettres écrites d'Égypte et de Nubie, en 1828 et 1829* (Paris, 1833), pp. 239–41.

[5] *Die Chronologie der Aegypter* (Berlin, 1849), p. 111.

[6] *Die thebanischen Tafeln stündlicher Sternaufgänge* (Leipzig, 1872).

[7] *TSBA* 3 (1874), pp. 400–21.

[8] *Die Sterntafeln in den ägyptischen Königsgräbern von Bibân el Molûk* (Stuttgart, 1891). This monograph, based on the texts **A** and **D** (*infra*, pp. 1, 3), contains many valuable observations of details.

[9] *Aegyptologische Studien* 1, pp. 57–128 (=Heft 2).

later, Borchardt, accepting the interpretation as transits, suggested a specific procedure by means of which the plumb line instrument known as the *mrḫt* could have been used to observe them.[1] The whole was then summarized again by Borchardt in his *Zeitmessung* (1920), pp. 53–58.

When we describe the Ramesside star tables as lists of transits the reader should not be misled into associating with this term any astronomical accuracy we are accustomed to assume for transit observations. Actually the sources of inaccuracy in the Egyptian procedure are only too apparent. That two persons, sitting opposite each other, cannot resume exactly the same position night after night is clear. To fix accurately the moment of transit, when even very small motions of the eye of the observer will displace the apparent position of a star, is impossible. Even if we assume optimistically that the target figure was replaced by a fixed statue the least shift of the observer's location would influence badly the accuracy of timing. Schack-Schackenburg assumed that a frame with vertical strings was used to give precision to such vague terms as "on the shoulder", "on the ear", etc. Though we have no evidence to support such an assumption the results would still be crude, if only from the lack of definition of the position of the observer's eye with respect to distance, altitude above the horizontal level and deviation from the exact meridian line. And whatever results might have been obtained in one place could not be repeated with any accuracy by another observer and target somewhere else. To this has to be added the well known inaccuracy of time measurement by water clocks,[2] which must have been the instrument on which the star tables were built.

In short: Just as in the case of the decans[3] the crudeness of the underlying procedures is so great that only under severely restrictive assumptions could numerical conclusions be abstracted from the given lists. If we add the fact of obvious errors and carelessness in details in the execution of the texts as we have them one would do best to avoid all hypothetical structures designed to identify Egyptian constellations from the analysis of the Ramesside star clocks.

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[1] *ZÄS* 37 (1899), pp. 10–17.

[2] *Zeitmessung*, p. 15 ff.

[3] *EAT* I, p. 95.

CHAPTER I

THE SOURCES AND THEORY OF THE RAMESSIDE STAR CLOCKS

A. *The Sources*

The texts of the twenty-four star clock tables with which we shall deal are from ceilings in three royal tombs of the Twentieth Dynasty, one of which gives the tables twice. The ceilings incorporate other astronomical elements, list of decans and their divinities, constellations and days of the lunar month, with which we shall not concern ourselves in this volume. We shall refer to the star clock texts as follows:

A Monument: Tomb of Ramses VI (No. 9) in the Valley of the Kings, Luxor.

Date: Dyn. XX, Ramses VI (1148–1138 B.C.).

Location: Lower registers to north and south of the ceiling of Hall E, which is entered from the east. Tables 1 to 12 are to the south, running from west to east. Tables 13 to 24 are to the north, running from east to west. The complete ceiling—except for the central part—is shown in Plates 1–2, which use photographs kindly supplied us by Miss Natacha Rambova. The tables are given individually in Plates 9–67. Diagrams of the ceiling are also to be found in Piankoff, *Tomb of Ramesses VI*, figs. 137–38.

Other Data: The registers of tables are 7·22 m. long by 88·3 cm. wide. Hieroglyphs and lines are light yellow on a blue background. The target figures are dark yellow or orange with red lines; eyes, eyebrows and beard are black.

Bibliography: Champollion, *Mon.*, III, pls. cclxxii bis–quint.
Champollion, *Not. Descr.*, II, pp. 547–67 (in part).
Brugsch, *Thesaurus*, pp. 187–94.
Porter-Moss I, pp. 8–11.
Piankoff, *Tomb of Ramesses VI*, pls. 162–71 and pp. 429–32.

Present Text: Photographs by Dr. Charles F. Nims, collated with the original in March, 1951.

B Monument: Tomb of Ramses VI (No. 9) in the Valley of the Kings, Luxor.

Date: Dyn. XX, Ramses VI (1148–1138 B.C.).

Location: Lower registers of ceilings of corridors A and B.
Tables 1 to 12 are in corridor A, beginning from the entrance to the tomb, the east. Tables 13 to 24 are in Corridor B. The complete ceilings are shown in Plates 3–6. The tables are given individually in Plates 9–67.

Other Data: Corridor A is 13·50 m. long and the table register is 1·15 m. wide. Corridor B is 12·30 m. long and the table register has the same width as in corridor A. After Table 12 in corridor A there was probably a sun disk, now completely missing. The ceilings of both halls have suffered greatly and little of their painting remains. The colors of the hieroglyphs, etc., and the target figures are as in text **A**.

Bibliography: Porter-Moss I, pp. 8–10.
Piankoff, *Tomb of Ramesses VI*, pls. 142–44; 146–48 and pp. 384–85.

Present Text: Photographs by Dr. Charles F. Nims, collated with the original in March, 1951.

C Monument: Tomb of Ramses VII (No. 1) in the Valley of the Kings, Luxor.

Date: Dyn. XX, Ramses VII (1138–1137 B.C.).

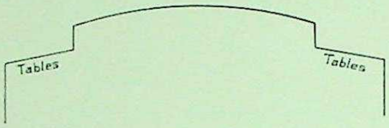

Fig. 1

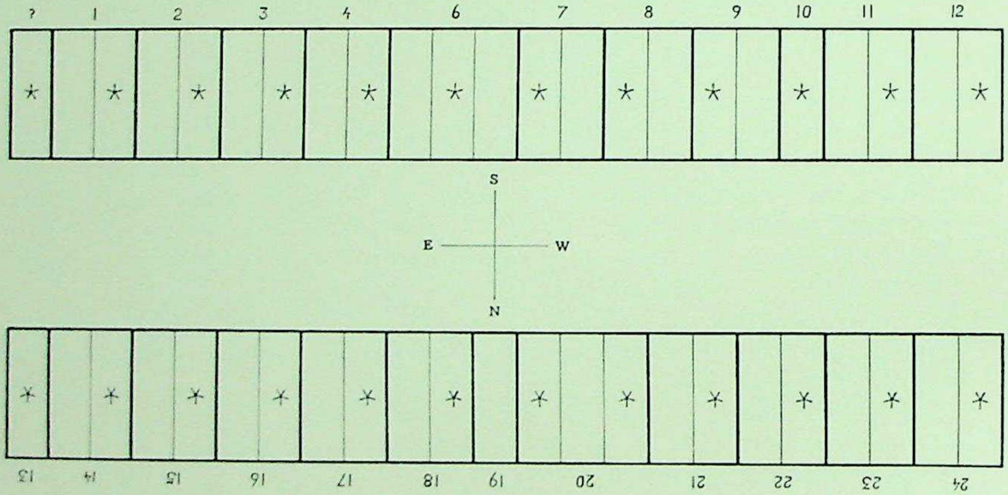

Fig. 2

Location: North and south shoulders of the vaulted ceiling of Hall B, which is entered from the east; see Fig. 1 for a cross-section of the ceiling. Fig. 2 shows the location of the tables which are rather disorganized on this ceiling. It is clear that the draftsman who laid it out began and ended each strip with a chart. While he made 12 of these, this arrangement permitted only 11 texts with resulting confusion. The scribe who filled in the south strip ran into considerable trouble. Confronted by the chart at the beginning and aware that the correct order for a table was text followed by chart, he arbitrarily drew in stars which fit no text at all. Then he correctly filled out Tables 1 to 4, omitted Table 5, gave the text of Table 6 twice around its chart, reversed the order of text and chart in Tables 7 to 9, gave Table 10 in chart only, and finished with Tables 11 and 12 in correct order. The scribe on the north strip did much better. He used the initial chart for Table 13, omitting the text entirely. Then he was able to follow through the rest of the Tables 14 to 24 in correct order, except for the mistake of giving the chart of Table 20 to Table 19 as well. The tables are given individually in Plates 9–67. Plate 7 shows the vault of the ceiling, separated by architraves from the shoulder texts.

Other Data: The shoulders are 8·50 m. long and 1 m. wide, with margins above and below the tables totalling 10·7 cm. Hieroglyphs are black, lines are red, on a dark yellow background. The target figures are yellow with red lines and black eye-brows on a blue background.

Bibliography: Porter-Moss I, pp. 1–2.

Present Text: Photographs by Dr. Charles F. Nims, collated with the original in March, 1951. Because the black hieroglyphs have in places disappeared and taken with them the yellow underneath they can be seen as light signs against the darker background. This has been cleverly brought out by Nims through the use of various filters, which are indicated in the plates of the individual tables.

D Monument: Tomb of Ramses IX (No. 6) in the Valley of the Kings, Luxor.

Date: Dyn. XX, Ramses IX (1130–1111 B.C.).

Location: Lower registers to north and south of the ceiling of corridor B, which is entered from the west. Tables 1 to 6 run from west to east on the north and Tables 19 to 23 and 13 run from east to west on the south. The complete ceiling is shown in Plate 8, part of which is from photographs kindly supplied by Miss Natacha Rambova. The tables are given individually in Plates 9–67.

Other Data: The table registers are 8·41 m. long and 73 cm. wide. Hieroglyphs and lines are yellow on a blue background which in some areas has faded. The target figures are dark yellow with red lines. They intrude into the fields of stars and distort their locations.

Bibliography: Champollion, *Not. Descr.*, II, pp. 547–67 (in part).
Lepsius, *Denk.*, III, pl. 228 bis.
Brugsch, *Thesaurus*, pp. 187–94.
Porter-Moss I, pp. 2, 6.

Present Text: Photographs by Dr. Charles F. Nims, collated with the original in March, 1951. Different filters were again found useful in bringing out the hieroglyphs.

B. *The Hour Stars and the Decans*

Before taking up the texts of the Ramesside star clocks directly and endeavoring to reconstruct to a certain degree the archetype from which they are the faulty descendants it will be useful to compare and contrast them with the transit decanal star clocks[1] in general descriptive terms.

1. They both use transits to measure the hours, but while the decanal star clocks use the meridian only, the others use not only the meridian but also lines before and after it.

2. The decanal star clocks have thirty-six tables of twelve "decanal" stars which indicate the ends of the twelve hours of the night; the Ramesside star clocks have twenty-four tables of thirteen "hour" stars, the first of which marks the beginning of the night.

3. The decanal star marking the end of the twelfth hour does not change at all as it marks in successive ten-day periods the ends of the eleventh, tenth, ninth, etc., hours; the hour star never moves forward in regular fashion for more than a few fifteen-day periods. Invariably between the twelfth hour and the beginning of night it will be found to have skipped two or three hours and frequently to have been replaced by another star as well.

---

[1] *EAT* I, pp. 113–15.

4. In elaboration of the foregoing observation it may be remarked that the decanal hours remain fixed in length. The hours of the Ramesside star clocks, because of substitution of stars and shifting hour boundaries on, before or after the meridian, frequently vary in length.

5. The decanal stars and the hour stars are very seldom the same. To emphasize this one need only compare the thirty-six decans with the twenty-seven hour stars as listed in the first table and the twelfth hour of the following tables. As *spdt*, Sirius, is common to both lists, that star must be the fixed point to start from. The decans are given in the order of the tables of Text U of the ceilings of Seti I and Ramses IV,[1] but numbered according to the concordance given in the first volume.[2]

	DECANS	HOUR STARS
31	*spdt*	*sbꜣ n spdt*
31b	*štw*	*tpy-ʿ sbꜣwy*
32	*knmt*	
34	*ẖry ẖpd knmt*	*sbꜣw nw mw*
35a	*ḥꜣt ḏꜣt*	*tp n mꜣi*
36a	*pḥwy ḏꜣt*	*sd.f*
1, 2	*tmꜣt ḥrt ẖrt*	
3	*wšꜣti bkꜣti*	*sbꜣw ʿšꜣw*
4	*ipḏs*	*šmsw n ḥꜣt n mnit*
5	*sbšsn*	*šmsw n mnit*
5a	*tpy-ʿ ḫntt*	
6	*ḫntt ḥrt*	*pd n rrt*
7	*ḫntt ẖrt*	*ḥry-ib mnty.s*
8	*ṯms n ḫntt*	*ẖpd.s*
9b	*spty ḫnwy*	
11	*ḥry-ib wiꜣ*	*mndt.s*
12a	*sšmw*	*šwty.s*
13	*knm*	*tpy-ʿ šwty nt nḫt*
13a	*tpy-ʿ smd*	
14a	*smd*	*šwty nt nḫt*
15	*srt*	*tp n ḥḏ nt nḫt*
16	*sꜣwy srt*	*nḥbt.f*
17	*ẖry ẖpd srt*	
18	*tpy-ʿ ꜣḫwy*	*bgs.f*

[1] *EAT* I, pp. 84–86.

[2] *EAT* I, pp. 2–3.

	DECANS	HOUR STARS
19	*ꜣḫwy*	*sḏḥ.f*
	tpy-ʿ bꜣwy	*pt.f*
21	*bꜣwy*	
21a	*ḫntw ḥrw*	*ʿryt*
21b	*ḫntw ẖrw*	*tp n ꜣpd*
22a	*sꜣwy ḳd*	*kft.f*
23	*ḫꜣw*	
24	*ʿrt*	*sbꜣ n ḫꜣw*
26	*rmn ḥry*	*sbꜣ n sʿr*
26b	*ṯs ʿrḳ*	*tpy-ʿ sꜣḥ*
29	*wʿrt*	
30	*tpy-ʿ spdt*	*sbꜣ n sꜣḥ*

Besides the agreement of the decan and the hour star, Sirius, we can also equate *ḫꜣw* (23) with *sbꜣ n ḫꜣw* and, of course, *sbꜣ n sꜣḥ*, "star of Orion", with one of the decanal stars of that constellation. But beyond these there is no point of similarity.[1] The constellations in the hour stars of *mꜣỉ*, "lion", *mnỉt*, "mooring post", *rrt*, "hippopotamus", *nḫt*, "giant", and *ꜣpd*, "bird", have no echoes at all in any of the decans.[2] Clearly they must lie outside the decanal belt.

C. *Concordance of the Hour Stars*

Because of the predominance of constellations it will be convenient to group the hour stars accordingly, instead of merely numbering or lettering them consecutively. We begin with the largest constellation (which, incidentally, begins the first table) by assigning a letter to the constellation and then numbering the individual stars which make it up in their natural order.

It should be noted that after the first entry of the full name of a constellation in a table the following hour stars may use a suffix pronoun to refer to it. Minor variants in orthography are of frequent occurrence.

To avoid confusion with the text sources, **A**, **B**, **C** and **D**, we begin with E for the constellations of hour stars.

E *nḫt*, "giant"

1. *tpy-ʿ šwty nt nḫt*, "predecessor of the two feathers of the giant": Not strictly a star in the constellation proper, but best grouped here.
2. *šwty nt nḫt*, "the two feathers of the giant".
3. *tpy-ʿ ḥḏ.f*, "predecessor of his mace": Though *ḥḏ* is sometimes written with the white crown that cannot be the meaning here, as the two feathers as headdress exclude another crown. However, "mace" is masculine, *ḥḏ*, and there may well be some confusion between "mace" and "white crown", *ḥḏt*, in the scribe's mind because of the genitive *nt* in E_5 and E_6.
4. *tp nḫt* (*tp.f*), "head of the giant, (his head)".

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[1] The stars *ʿrt* (see *infra*, p. 77, Additions and Corrections to Volume I, p. 3) and *ʿryt* in the lists cannot be identical since in the decans *ʿrt* follows *ḫꜣw* and in the hour stars *ʿryt* precedes, with the *ꜣpd*-stars in between.

[2] For such translations of the decanal stars as are possible see *EAT* I, pp. 24–26.

5. *tp* (*n*) *ḥḏ nt nḫt*, "head of the mace of the giant".
6. *ḥḏ nt nḫt*, "mace of the giant". There is a possibility of confusion and error in E_3, E_4, E_5 and E_6 as they replace one another in various tables and never are found in successive hours.
7. *nḥbt nḫt* (*nḥbt.f*), "neck of the giant, (his neck)".
8. *ḫꜣb.f*, "nape of his neck": E_7 and E_8 also interchange in tables and are never found in successive hours.
9. *mndt.f*, "his breast".
10. *bgs nḫt* (*bgs.f*), "⸢hip⸣ of the giant, (his ⸢hip⸣)": This part of the giant's body is not certainly identifiable. It must be roughly equidistant between breast and shank.
11. *sḏḥf*, "his shank".
12. *pd nḫt* (*pd.f*), "knee of the giant, (his knee)": This star interchanges with E_{11} and they are never found in successive hours.
13. *sbḵ.f*, "his foot": Since this follows either E_{11} or E_{12} in some tables it must be restricted to the lowest part of the leg and not be, as elsewhere, a term for leg or shin.
14. *pt.f*, "his pedestal": The giant was seen as standing on some sort of support or platform.
15. *iy sꜣ pt.f*, "the one coming after his pedestal": This star interchanges with E_{14} and they never occur in successive hours; *sꜣ* is no doubt the shortened form of *ḥr-sꜣ*.
16. *sbꜣ n sꜣ pt*, "star of the back of the pedestal": This, from its use, must clearly be distinguished from E_{15}. It occurs only in Table 7, and may be there an alternative star to F.

F *ʿryt*: A solitary hour star whose name cannot be translated and is not to be identified with the decan *ʿrt*, cf. p. 5, n. 1.

G *ꜣpd*, "bird"

1. *bʿnt nt ꜣpd* (*bʿnt.f*), "beak of the bird, (its beak)".
2. *tp n ꜣpd*, "head of the bird".
3. *ḫtyt nt ꜣpd*, "throat of the bird": This is also a doubtful hour star, as part of the bird, but in any event it interchanges with G_1 and G_2 and none of them occurs in successive hours.
4. *kft.f*, "its rump".

H *sbꜣ n ḫꜣw*, "star of the thousands": This is also a decan, cf. *supra*, p. 5.

J *sbꜣ n sʿr*, "star of *sʿr*": No translation of *sʿr* can be given.

K *sꜣḥ*, "Orion"

1. *tpy-ʿ* (*sbꜣ n*) *sꜣḥ*, "predecessor of (the star of) Orion".
2. *sbꜣ n sꜣḥ*, "star of Orion": It is, of course, impossible to say which of the stars of the constellation is meant.

L *spdt*, "Sothis"

1. *sbꜣ n spdt*, "star of Sothis": This is, of course, Sirius and also a decan, *supra*, p. 4.
2. *iy ḥr-sꜣ* (*sbꜣ n*) *spdt*, "the one coming after (the star of) Sothis".

M *sbꜣwy*, "the two stars"

1. *tpy-ʿ sbꜣwy*, "predecessor of the two stars".
2. *sbꜣwy*, "the two stars".

N *sbꜣw nw mw*, "the stars of the water"[1]

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[1] It is extremely doubtful that these "stars of the water" have any connection with the *sbꜣ n mw* of B. M. Ostracon 5625 (*ZÄS* 6 (1868), pp. 11–12 and Le Page Renouf, *Life-work* III, pp. 102–3). It is our belief that the latter is the same *sbꜣ mw* which is found in texts on certain of the cubit rods (*Zeitmessung*, Taf. 11). We hope, at a later date, to investigate these.

O *mꜣi*, "lion"
  1. *tp n mꜣi*, "head of the lion".
  2. *sd n mꜣi* (*sd.f*), "tail of the lion, (his tail)".

P *sbꜣw ʿšꜣw*, "the many stars"

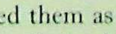
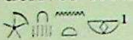
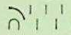
Q *mnit*, "mooring post"
  1. [⸢*tpy-ʿ*⸣] *mnit*, "[⸢predecessor⸣] of the mooring post": This appears only in Table 17 and the restoration is not at all certain. Another possible restoration, based on Q_3, would be *ḥꜣt*, "front". The star seems also to be an alternate to P.
  2. *tꜣ nfr*: This is not translatable with any certainty and may, like Q_1, be actually outside the constellation proper.
  3. *šmsw* (*n*) *ḥꜣt* (*n*) *mnit*, "follower of the front of the mooring post".
  4. *mnit*, "mooring post".
  5. *šmsw* (*n*) *mnit*, "follower of the mooring post": From Q_4 and Q_5, which appear in successive hours, it is clear that *šmsw* means not merely a companion, a very close star, but one which follows at a distance.
  6. *šmsw iy ḥr-sꜣ mnit*, "follower which comes after the mooring post": This star interchanges with Q_5 and they never appear in successive hours.

R *rrt*, "(female) hippopotamus": As the sequence of hour stars will show, the animal was conceived as standing upright on its hind legs, like the goddess Ipet.
  1. *rdwy* (or *rd*) (*n*) *rrt*, "feet (*or* foot) of the hippopotamus".
  2. *pd n rrt* (*pd.s*), "knee of the hippopotamus, (her knee)".
  3. *ḥry-ib* (*n*) *mnty.s*, "middle of her thighs".
  4. *bꜣḥ n rrt* (*bꜣḥ.s*), "private part of the hippopotamus, (her private part)": The usual rendering, "phallus", is not, of course, appropriate. R_3 and R_4 interchange with one another and never appear in successive hours.
  5. *ḫpd n rrt* (*ḫpd.s*), "buttocks of the hippopotamus, (her buttocks)".
  6. *mndt n rrt* (*mndt.s*), "breast of the hippopotamus, (her breast)".
  7. *ns.s*, "her tongue".
  8. *šwty n rrt* (*šwty.s*), "the two feathers of the hippopotamus, (her two feathers)".

To what extent, if at all, the constellation of the lion, the mooring post, the hippopotamus, and perhaps others, can be identified with similar figures in the so-called "northern" constellations as depicted on many astronomical ceilings (cf. Plates 1–8 in this volume for examples) is a problem into which we do not intend to enter until all the evidence can be presented in our final volume. That the problem is more complex than would appear at first glance—at least in so far as the two hippopotami are concerned—is sufficiently indicated by the fact that on the ceilings the hippopotamus is *never* named *rrt*, *never* is shown wearing two feathers as a headdress, and very frequently has a crocodile on its back.

D. *General Commentary to the Tables*

The first line in each table gives the date as either the first or the sixteenth day of the four months in each of the three seasons of the Egyptian civil year. The epagomenal days are not specifically mentioned but we shall see later (p. 67) that there are reasons to believe that the twenty-fourth table included them as well as the last half of the fourth month of Shomu.

The first day is indicated only by the sun-disk but the middle of the month has a formula which, for I *ꜣḫt*, is written  (*sw*) *16 smdt*, "day 16, the half-month". The reading derives from our belief that such a writing of the fifteenth day of the lunar month as [1] has been modified, first to  and then, since and are written the same in hieratic,[2] to the form in our text. Since the mention of the fifteenth day of the lunar month would be irrelevant, it is clear that it is the other aspect of *smdt*, "half-month day", here extended to mean a half-month period and applied to a civil rather than to a lunar month, that is appropriate to the context.

Following the date we invariably find *tp grḥ*, "beginning of the night", which leads to the particular hour star and its location relative to the target figure. On succeeding lines of the table the other twelve stars and their locations are introduced by *wnwt tpy*(*t*), "first hour", through to *wnwt 12-nwt*, "twelfth hour". Naturally there are the usual variations in orthography. It should be remembered that the star chart provides an independent check on the location of the hour stars, though the scribe of **C** sometimes placed a star in the space before or after its proper line. It should also be noted that **D** uses twelve lines only in its tables and usually crowds the beginning of the night and the first hour texts into one line. In some tables, however, it gives them two lines and then omits the twelfth hour.

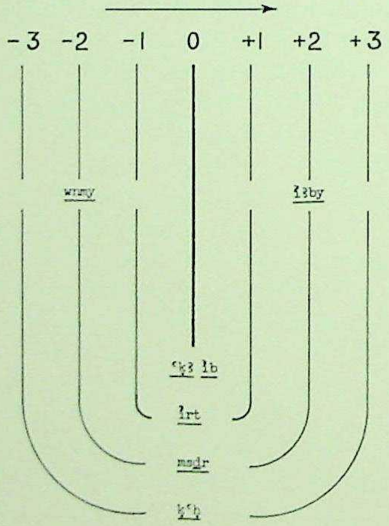


Fig. 3

In presenting the tables we shall use 0 to mean the beginning of the night and number the hours 1 to 12. The stars and their locations will be given in transliteration only and then diagrammatically, using the concordance letters and numbers for the stars with +1, +2, +3 for location on the target to the right of 0 (=*r ʿḳ3 ib*, the meridian) and −1, −2, −3 for locations to the left of 0. Fig. 3 will make this clear. Notes and commentary to each table will be added as appropriate.

The texts of all the tables, grouped hour by hour, are given in hand copy on Plates 29–67. While an attempt has been made to preserve the peculiarities of individual signs it should be emphasized that the hand copies are not facsimiles and palaeographical questions should be settled by reference to the photographs.

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[1] Parker, *Calendars*, §§ 36, 42.

[2] Möller, *Hier. Pal.* II, Nos. 160 and 316.

E. *Approximate Date of the Construction of the Tables*

To reach an insight into the details of the method of counting time by means of culminations, or near culminations, requires a great deal more discussion. Before turning to it, however, we need to establish roughly the date at which this method was designed.

In Table 12, which concerns II *prt* 16, Sirius culminates at the beginning of the night. In the terminology of the ceiling in the cenotaph of Seti I[1] the star has then reached the "end of work". According to this scheme the date of "birth" falls 160 days later, i.e., III *šmw* 26. Since "birth" corresponds generally to heliacal rising we can say that III *šmw* 26 must be near the heliacal rising of Sirius. In the Seti cenotaph the "birth" date of Sirius is IIII *prt* 16[2] or 100 days earlier. Consequently our new texts are about 400 years later than those of the cenotaph which leads us to a year in the neighbourhood of 1470 B.C., i.e., more than three centuries earlier than the preserved monuments. As a round date we shall use in the following 1500 B.C.[3] An independent confirmation will be given below (pp. 39 and 73).

A final remark is needed concerning the measurement of time. In order to associate the culmination of stars with seasonal hours a device is required to divide the night into 12 approximately equal parts. In principle the uniform rotation of the stars would provide the ideal clock. We find, however, no trace of angular measurements in any Egyptian source before the Hellenistic period. And the very method of extremely crude transit observations on which our present texts are built excludes the existence of a much finer device of angular measurement as a preliminary step. Thus the only clock mechanism that remains is the water clock, an instrument which can be traced back to the sixteenth century B.C.[4] This agrees well with the above given date for the time of origin of time reckoning by means of star transits. But it is also clear that the notorious inaccuracy of water clocks[5] will be transmitted to the definition of hours by means of stars.

F. *Astronomical Considerations*

At first sight it is tempting to see definite progress in the change from the 10-day intervals of the decanal clocks to the 15-day intervals of the transit tables. Since the sun, in 15 days, progresses with respect to the stars about 15 degrees and since 15° correspond to 1/24 of a complete circle one might think that equinoctial hours had replaced decanal hours which were much too short.

But it is easy to see that no such methodical principle lies behind the new device. That we are not dealing with equinoctial hours is evident from the fact that every night throughout the year is divided into 12 hours. Furthermore we may expect that these nights cover only the period of complete darkness (in contrast to the span from sunrise to sunset) as the visibility of all stars would be desirable if stars should indicate hours. Thus we assume continuation of the definition of "night" as excluding twilight in the same fashion as we found it for the preceding period.[1] The investigation of the texts confirms this expectation (*infra*, p. 73). In the tables which are near the longest night we find much greater regularity in the relation between stars and consecutive hours from table to table than in those near the time of shortest night. In the first case the period of total darkness is about 12 equinoctial hours long and the stars represent nearly equinoctial hours when shifting one hour in 15 days. But for nights only about 8 equinoctial hours long 12 stars which culminate at about 8/12=2/3 hour intervals cannot work properly for any length of time.

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[1] Similarly Ramses IV and *P. Carlsberg* 1; cf. *EAT* I, p. 41.

[2] *EAT* I, p. 86.

[3] Starting from modern dates for the culmination of Sirius Schack-Schackenburg found a date "of about 1500 B.C." (*op. cit.*, p. 79). Le Page Renouf's date (*supra*, p. ix) was about 1450 B.C.

[4] *EAT* I, p. 119.

[5] *Zeitmessung*, p. 15 ff.

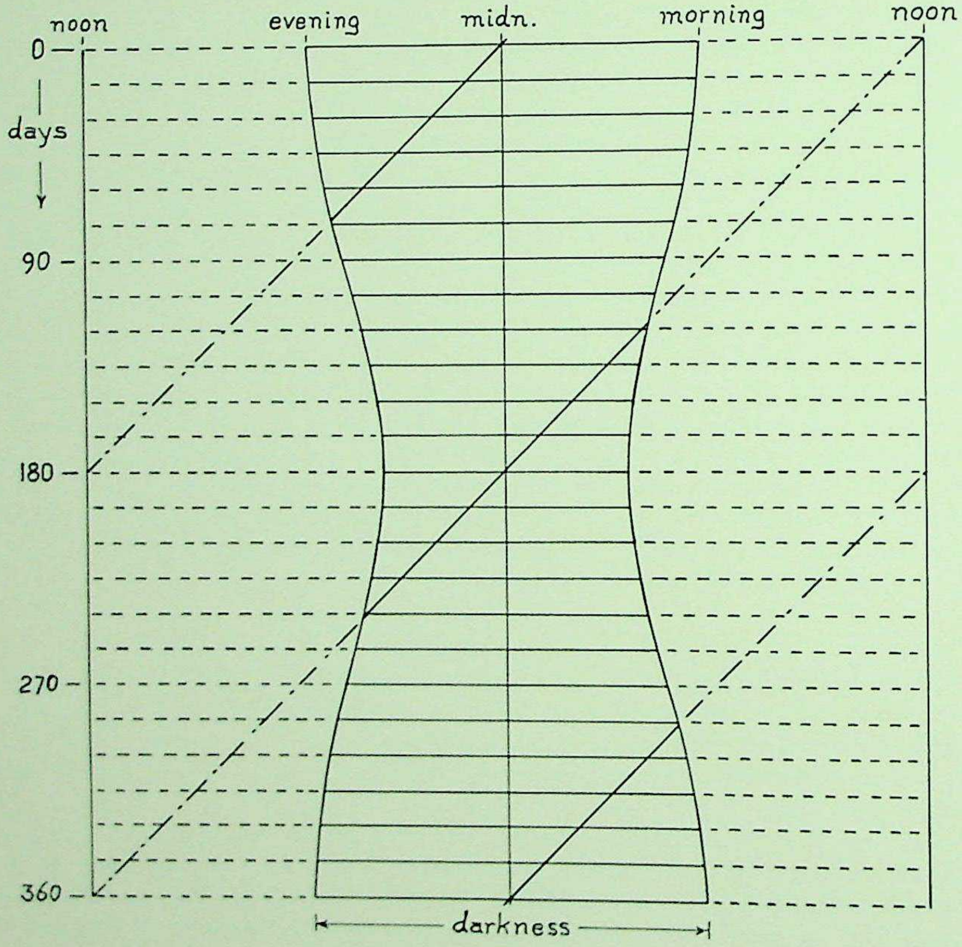

Fig. 4

This is easy to see by means of a schematic diagram as given in Fig. 4. Let us assume, for the sake of simplicity, that a year is 360 days long, that is to say that the sun returns after 360 days to the same position among the stars. Each horizontal line in Fig. 4 represents the time from noon to noon for days at intervals of 15 days' length, the middle part corresponding

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[1] Cf. *EAT* I, p. 105.

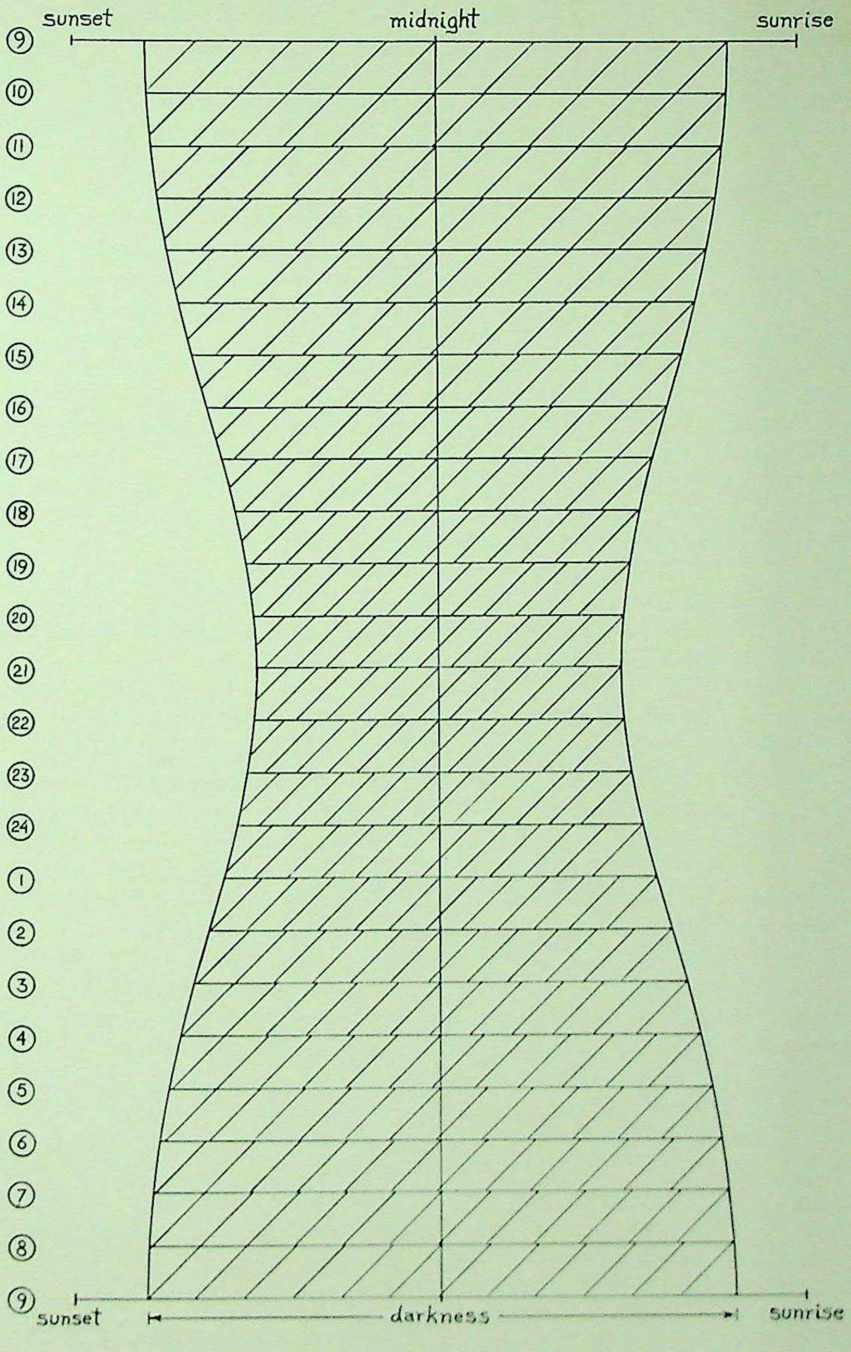
sunset
midnight
sunrise
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯
⑰
⑱
⑲
⑳
㉑
㉒
㉓
㉔
①
②
③
④
⑤
⑥
⑦
⑧
⑨
sunset
darkness
sunrise

Fig. 5

to the hours of complete darkness.[1] Since the sun moves about one degree per day from west to east with respect to the stars, the moment of culmination of a given star progresses by about 4 minutes daily with respect to the solar day. Since, according to our schematic arrangement, sun and stars return to the same relative position after 360 days the progress of the moments of culmination within the solar days will be represented in our diagram by a straight line which has the slope of a diagonal leading from noon at the beginning of the year to noon at the end of a year.

Using this method we have represented in Fig. 4 two cases, the first of which shows the successive moments of culmination of a star which culminates at the beginning of the year at midnight. As the year progresses the culminations approach sunset more and more until they occur in daylight and thus are no longer visible. This situation prevails for about 7 months until the star culminates before sunrise. From then on the culminations occur later and later at night until one year is completed and the star culminates again at midnight. The second case, which is represented by an unbroken diagonal, represents a star which culminates at the beginning of the year (invisibly) at noon. Its culminations are visible during about 4 months at the middle of the year.

We now apply this type of representation to the 24 tables of our texts. According to the date of about 1500 B.C. which we have established for the construction of these tables (*supra*, p. 9) we know that the longest night must correspond to about Table 9, the shortest night to Table 21. Let us still assume that the year is 360 days long, postponing the necessary adjustment for the epagomenal days to the discussion of Table 24 (*infra*, p. 67). We shall now see in a qualitative way what type of problems will arise when we assume that each night is divided by means of a water clock into 12 seasonal hours and stars are selected which culminate exactly 1/12 of the night apart. We then see from Fig. 5 that the stars which corresponded to equal hours in Table 9 still preserve this quality for Table 10 and fairly well through Tables 11 to 14. Since the same holds for Tables 7 and 8 we see that at the time of longest nights a star may indicate consecutive hours for as many as four months. At the period of shortest nights, however, even division of the night in any table will produce 15 days later very uneven hours at both ends of a night. In order to remedy this situation any star serving as hour star would have to be restricted to a smaller number of tables. Then other stars would have to be substituted or whole hours skipped in order to avoid hours at the end of a night more than twice as long as those at the beginning (cf. e.g., the situation depicted in Fig. 5 in the region of Tables 21 to 5).

Another approach to the problems inherent in the new tables is through Fig. 6. This is based on Fig. 5 but the line of the 12th hour star in every table is simply carried diagonally down through all the time of darkness. This, we may recall, was exactly the procedure followed by the decanal stars with their 10-day intervals (*supra*, p. 3). But with the new 15-day intervals it is at once apparent that, with the same procedure, *no* night would ever be divided into 12 hours. The range would be from 10 hours in Tables 14 and 15 as a maximum to slightly more than 8 hours in Table 1 with all the other tables in between. Moreover, no star beginning in the 12th hour could ever be serviceable for more than 11 tables (e.g., Tables 4 to 14) as a maximum, while as a minimum it might be serviceable for little more than 9 (e.g., Tables 17 to 1).[2]

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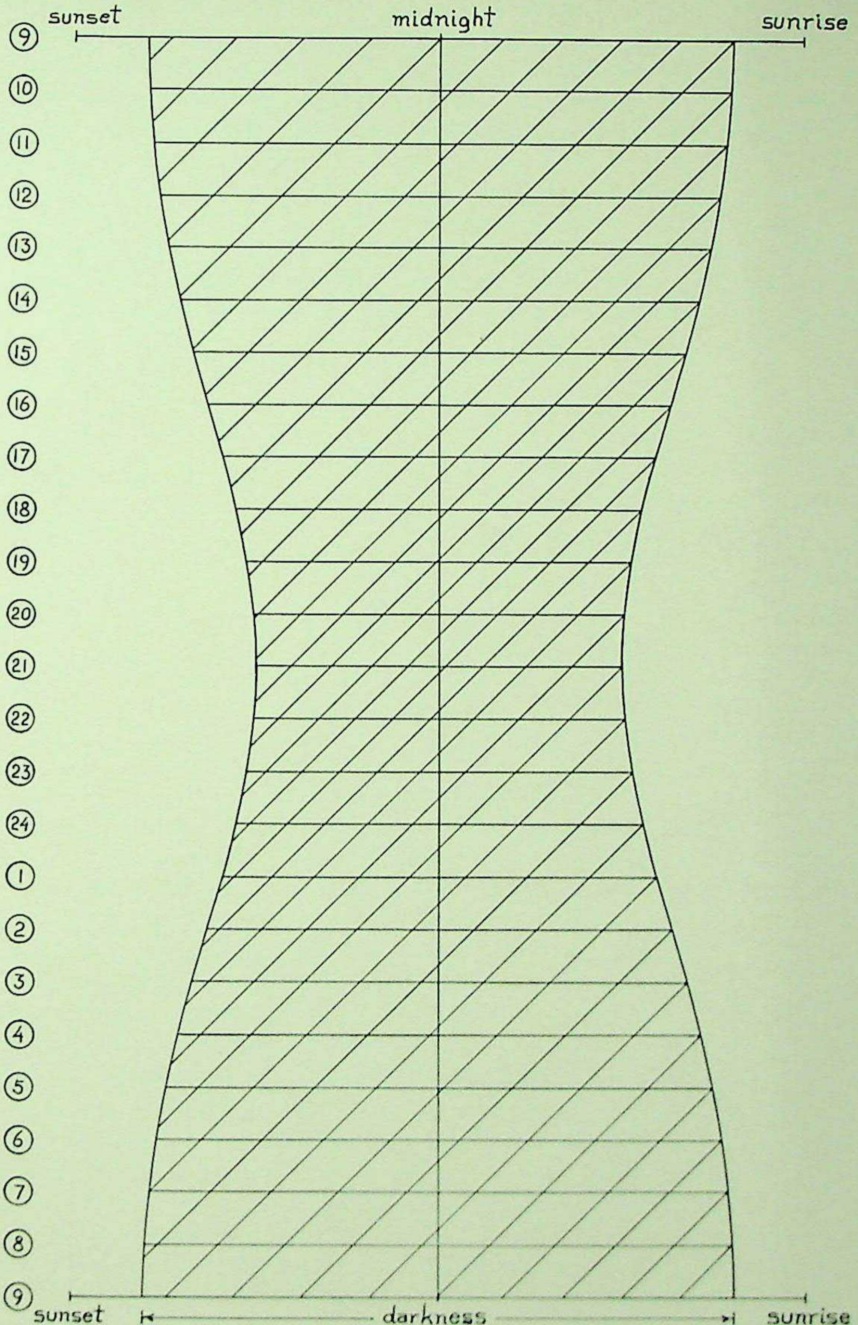
[1] The outline of the graph is the same as given by the dotted line in Fig. 29 of *EAT* I, p. 104.

[2] In actual practice, as we shall see later (pp. 70–73) the 12th hour stars or their substitutes extend through eleven tables when they begin Tables 1 to 14 and ten in Tables 15 to 24. This regularization means that the time boundaries of complete darkness were at times exceeded in the choice of hour stars.


sunset
midnight
sunrise
⑨
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⑳
㉑
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㉔
①
②
③
④
⑤
⑥
⑦
⑧
⑨
sunset
darkness
sunrise

Fig. 6

These remarks suffice to demonstrate that the whole method of definition of seasonal hours by means of transits and 15-day intervals necessarily leads to great difficulties. If we add to this theoretical situation the inaccuracy inherent in the definition of transits with respect to a seated figure and the inaccuracy of hours shown by a water clock we need not be surprised by the unevenness of hours which is amply revealed by a closer study of the star tables.

The preceding discussion shows that the definition of seasonal hours of darkness by means of transits faces inevitably great practical difficulties which could only have been overcome by the use of accurately working water clocks which then would be used to select at the end of each hour a suitable star, culminating at the given moment. This would mean, however, that for almost all tables a new set of stars should have been selected.

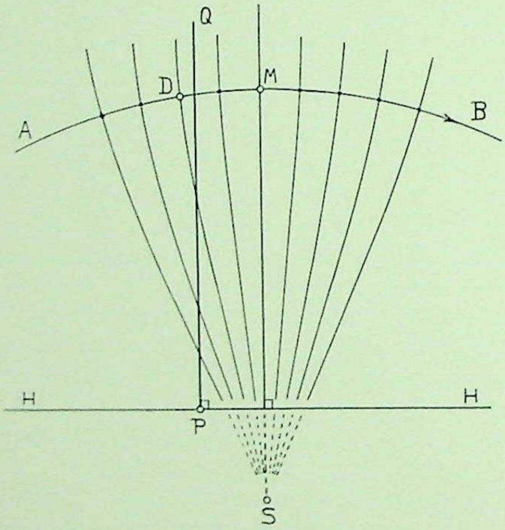

Fig. 7

The Egyptian did not choose this procedure but fell on a remedy which is from a theoretical point of view most unsatisfactory. One may assume that transits with respect to the meridian can be observed with a fair amount of accuracy. But if the central vertical line in the star charts of our texts represents correctly the meridian then the "transits" with respect to the three parallel lines to the right and left introduce an element practically out of control. Since we are obviously dealing with large extended configurations of stars it is evident that they are not neatly lined up on the equator (not to mention that there is no trace of the concept "equator" in our sources). Thus we have to face the following alternatives. If the secondary transit lines were very close to the meridian then the shifts between + or — transits mean little for the duration of hours. If on the contrary the lines +3 and —3 are at a distance of, say, 5° or 6° from the meridian then the declination of a star plays a very great role on the time of transit of lines which are perpendicular to the horizon.

The following schematic drawing (Fig. 7) may help to illustrate the situation. The south pole S of the celestial sphere lies, in Egypt, only 30° or less below the horizon H. All points on a circle of declination SD represent the same time difference from the meridian SM. But if the secondary transit lines PQ are perpendicular to the horizon a star of low altitude (near the horizon) requires a much greater time to reach the meridian than a star near the equator AB. In other words, the + and — values of the secondary transits may very well vary from star to star and since we know nothing about the location of our stars in the sky we have no estimate whatever about the possible changes of hours on account of secondary transit lines. The reader must keep in mind that all data which depend on + or — transit lines are sheer guesswork.

It cannot be too strongly emphasized that all attempts to deal with these texts as if they were reliable astronomical observations in order to deduce from them identifications of Egyptian constellations are doomed to failure.

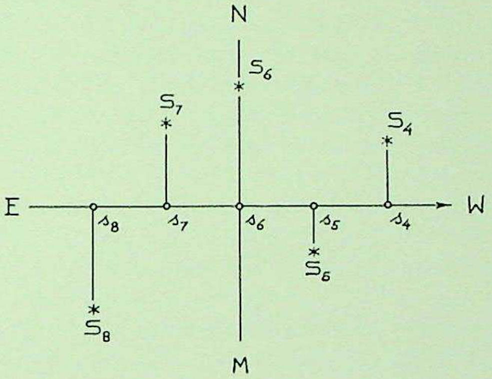

Fig. 8

G. *Explanation of Tabular Diagrams*

The variants in our texts and the discrepancies in the tables themselves make it necessary to discuss the 24 tables one by one. For these discussions it is useful to have schematic representations at one's disposal which illustrate for each table the division of the night in hours by means of the transits of certain stars as well as the relations between consecutive tables.

To this end we use a scheme which is equivalent to that of Figs. 4 and 5 but is closer to the actual appearance of the transits when observing the sky.

Let us assume an observer, looking toward the south and observing the meridian as the vertical line MN (Fig. 8) and the equator as a line orthogonal to MN, moving uniformly from E to W. Let us furthermore assume that a specific night (i.e., the period of darkness) has been divided by means of an accurate water clock into 12 equal parts and that stars. . ., S_4, S_5, S_6, S_7, S_8,. . . have been selected which cross the meridian exactly at the moments when the water clock indicates the end of the 4th, 5th,. . . , etc., hour. Fig. 8 illustrates the situation at midnight when S_6 is in the meridian; S_4, S_5,. . . have passed it, and S_7, S_8, are to be at the meridian in the subsequent hours.

Assuming a division of the night into equal parts is equivalent to saying that the points . . ., s_4, s_5, s_6, s_7, in which the circles of the declinations of respective stars. . ., S_4, S_5, S_6, S_7,. . . intersect the equator, are equidistantly spaced.[1] In other words, the intervals. . .,

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[1] That is to say that the stars have constant differences of right ascension; cf. *EAT* I, p. 123.

$s_4\, s_5$, $s_5\, s_6$, . . represent seasonal hours of constant length (expressible as equator arcs of equal number of degrees).[1]

Since we know little or nothing, generally speaking, about the positions of the hour stars (S) with respect to the equator we are actually dealing only with the corresponding points (s) on the equator. This does not imply that we ascribe to the Egyptian the use of equatorial arcs for time measurement—on the contrary nothing supports such a hypothesis—but we are forced to use in our discussion a representation of this type if we wish to investigate the astronomical significance of our lists of transits.

A much more serious element of incertitude is created by the use of "transits" of vertical lines east and west of the meridian. This produces two sources of divergence entirely beyond our control or even estimate. First, we do not know how far the verticals which we call $-3, -2, \ldots, +3$ are distant from the meridian and, secondly, verticals to the horizon and verticals to the equator do not coincide except for the meridian itself (*supra*, p. 14 and Fig. 7). Thus, even if we should know where the auxiliary verticals are located we would have to know the declinations of the stars—and this is not the case. Consequently, all our discussions contain elements of error which we have no means of eliminating, in addition to the equally unknown limits of error of the actual observations over the target figure and the inaccuracy of the water clocks.

Nevertheless we need some scheme to represent the data of the text. Let us for the moment assume that on a day n the night is 12 equinoctial hours long and each division is marked by the culmination of a star located in the equator. At the day $n+15$ each star will culminate one hour earlier because the sun has come about 15° nearer to the star in its motion from west to east. This situation is represented in Fig. 9 where the solid lines connect points on the equator belonging to the same star whereas the dotted lines connect boundaries of equal hours. We have chosen the horizontal and vertical scales in such a fashion that the lines associated with each star are sloped at 45° to the horizontal lines which represent the equator, at 15-day intervals.

We now apply this scheme to our texts. Each horizontal line represents the equator as seen at the date of one of the 24 tables which cover one year (around 1500 B.C.). For the

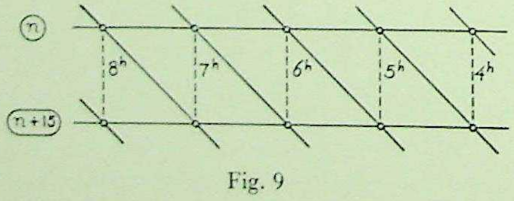

Fig. 9

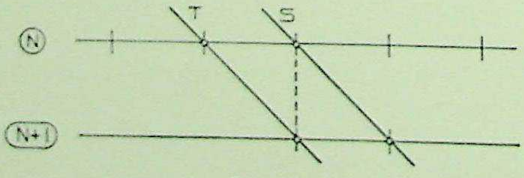

Fig. 10

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[1] In the case of equinoctial hours: 15°.

length of the night we assume in each table the value which we have used in our Figs. 4 and 5. Assuming that one of these nights (table N) is divided, by means of a water clock, in 12 equal parts we have divided the given length in 12 equal sections, marked in Fig. 10 by short vertical bars. If, according to the text, a star S culminates at the moment of division between two hours we mark this by a little circle at the point of division. Fifteen days later (table N+1) the same point of the equator will be moved toward the right (west). Assume again that the transit of S marks the end of an hour and that the same holds for a star T to the east of S. Then we know that the length of the hour in table N+1 is the same as the length of the corresponding earlier hour in table N, marked by the consecutive transits of S and T.

This, however, is only the ideal situation. In reality we cannot assume that a star lies on the equator and we have not only to deal with meridian transits but also with the crossings of one of the vertical lines between −3 and +3. Since we know nothing about the declinations of the hour stars we are forced to act as if the points of equal right ascensions on the equator were the stars themselves. Consequently we have to refer the crossings of one of the subsidiary verticals to a point of the equator which we have to place at a distance from the meridian proportional to the time required to move through the distance between the vertical line and the meridian. If, e.g., the end of an hour is marked by a star S crossing the line −3 it takes some additional rotation of the equator to the west before S reaches the meridian. Thus the point on the equator, associated with S, has to be located a certain distance to the left of the point which is exactly in the meridian at the end of the hour.

We do not know how far the distance between −3 and +3 can be. It seems plausible, however, that extremal positions could never overlap such that a star which crosses the +3 line could not be called −3 with respect to the preceding hour.[1] This leads to the following type of representation. In Table 6, e.g., we find that the ends of the hours 2, 3, 4 are indicated by the real transits of the stars G_2, G_4, H respectively (cf. Fig. 11). We assume that these hours are of equal length (namely 1/12 of the length of darkness at the time of the

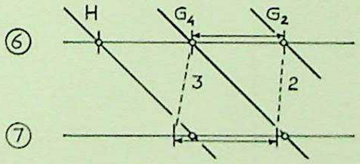

Fig. 11

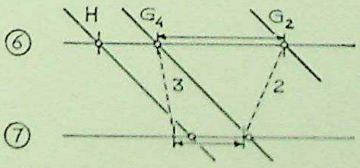

Fig. 12

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[1] We have chosen a scale such that 8 units represent an equinoctial hour. To the total range from −3 to +3 we have assigned the space of 3 units. This avoids overlapping even in the case of shortest hours.

year into which Table 6 falls). In Table 7 these 3 stars indicate the end of the hours by secondary transits namely

G_2: -1 G_4: $+1$ H: $+3$

This shows that the length of the third hour has increased from Table 6 to Table 7. It must be kept in mind, however, that this result depends on our assumption of equal division of time in Table 6. If, instead, G_4 would divide the space between G_2 and H as indicated in Fig. 12. the third hour in Table 7 would be shorter than in Table 6. In other words, the diagrams which we give with the individual tables are intended only to help visualize the relationship between consecutive tables and to illustrate our reasons for interpretations and emendations of the text. They cannot claim to represent metrically correct divisions of time resulting from the recorded transits.

Additional more or less arbitrary assumptions are required when a new star begins to serve, without being represented in the preceding table. This must occur of necessity for the star of the 12th hour because its culmination was invisible 15 days earlier. But frequently, also, there occur substitutions for internal hours. In every such case the new star has to be placed at a plausible point, which avoids too drastically uneven hours. Usually we have given the 12th hour the length of the preceding hour. With new hour stars an equal division of the available interval was assumed. In all these cases we have marked the connections of corresponding hours by broken lines.

In our discussion of the individual tables we make no attempt to combine them into longer coherent sequences. The little that can be concluded for the system as a whole will be said in the summary at the end (p. 70).

CHAPTER II

THE TEXTS OF THE TABLES

TABLE 1

(Plates 9, 29–30)

I ꜣḫt 1

(0)	*šwty nt nḫt*	[*msḏr ỉꜣby*]	(0)	E_2 +2
(1)	*tp n ⟨ḥḏ⟩ nt nḫt*	*msḏr wnmy*	(1)	E_5 −2
(2)	*nḥbt.f*	*ꜥḳꜣ ib*	(2)	E_7 0
(3)	*bgs.⟨f⟩*	*ꜥḳꜣ ib*	(3)	E_{10} 0
(4)	*sḏḥ.f*	*ḳꜥḥ ỉꜣby*	(4)	E_{11} +3
(5)	*pt.f*	*irt ỉꜣby*	(5)	E_{14} +1
(6)	*ꜥryt*	*ꜥḳꜣ ib*	(6)	F 0
(7)	*tp n ⟨ꜣpd⟩*	*ꜥḳꜣ ib*	(7)	G_2 0
(8)	*kft.f*	*irt wnmy*	(8)	G_4 −1
(9)	*sbꜣ n ḫꜣw*	*ꜥḳꜣ ib*	(9)	H 0
(10)	*sbꜣ n sꜥr*	*ꜥḳꜣ ib*	(10)	J 0
(11)	*tpy-ꜥ sꜣḥ*	*ꜥḳꜣ ib*	(11)	K_1 0
(12)	*sbꜣ n sꜣḥ*	*ḳꜥḥ ⸢wnmy⸣*	(12)	K_2 −3

NOTES

Only a few stars of **B** are preserved and very little more of **C**. **C** has a chart before the text which has nothing to do with Table 1, nor indeed with any other table; see *supra*, p. 2.—**D** has 0 and 1 on one line in the text but the stars are not doubled up.

0. No text preserves the location. **D** has its star at +2. **A** has it at +1 but the stars for the first, second and third hours of **A** (and **B** where preserved) have all to be shifted one position to the right to agree with the text and the other stars. It is likely then that here also the star of **A** should be moved to +2.—The first traces in **A** suggest the restoration as given but nothing beyond it.

1. The stars of **A** and **B** are to be shifted one position to the right to agree with **D** and the text of **A**. **D** also has *msḏr* but lack of space prevented the addition of *wnmy*.—The sign 𓋴 in **D** must be an error for 𓎛, possibly through the hieratic. It is also conceivable that the 𓈖 of *tp n* should be emended to —⊐ (E$_3$) but we do have *tp ḥḏ* (Table 17, 12) and the addition of *n* is not remarkable, cf. G$_2$, *tp n ꜣpd*.

2. The star in the correct position in **A** was presumably added later without erasure of the erroneous one.—**D** (here and in Table 1, 5) and **C** in Table 3, 3 and Table 7, 2 add *ḥr* before the star as though underlining its location.

3. The stars of **A** and **B** are to be shifted one position to the right to agree with **D** and the texts.—**D** omits *.f* after *bgs* and has 𓏏 for 𓎛.

4. In **A** no doubt emend *wnmy* to *iꜣby* to agree with the stars and **D**, as well as Table 2, 3.—**D**, ⫯ is for ⟍ through hieratic confusion.

5. The stars of **A** and **D** should be shifted one position to the left to agree with the texts. This location is also preferable from Table 2, 4, *q.v.*—The text of **C** is out of place and belongs to the next hour, 6.—**D**, emend 𓇯 to 𓌔, an error through the hieratic or through confusion between *pt* and *pd*. On the presence of *ḥr* see note to 2 above.

6. The text of **C** is probably misplaced and should be in the next hour, 7; because of the difference in length it is unlikely to have repeated 5, **C**.—Because the target figure intrudes into the chart the positions of the stars of **D** from this hour on are valueless as absolute data, but they are sometimes useful relative to one another.

7. **D** must be emended to *tp n* ⟨*ꜣpd*⟩ as in Table 2, 6 ff.

8. **D** has an intrusive 𓂋 in *kft*, which may have been originally 𓏏.

12. **A** omits its star.—In **D** it is just possible that ⟹ is an error for ⩸ as in 4, **D**. In that case emend ⸾ to ǂ as the more likely. Were it *ḳꜥḥ iꜣby* the star of **D** could have been placed correctly to the right of the target figure.

COMMENTARY

In 1501 B.C., the date about which our star clock was constructed, I *ꜣḫt* 1 in the Egyptian year was August 20 greg. June 21, the shortest night, was III *šmw* 6 or Table 21. December 21, the longest night, was I *prt* 4 or Table 9. From Table 21 to Table 9 the nights and the hours of the night were growing longer. The star of the 12th hour in Table 21 is *pt.f* (E$_{14}$) and there are seven stars (six hours) from *šwty nt nḫt* (E$_2$) to E$_{14}$. In Table 1 there are only six stars (five hours) from E$_2$ to E$_{14}$. Clearly the five seasonal hours of Table 1 cover essentially the same time span as the six seasonal hours of Table 21.[1] And we may expect also that the remaining hours of Table 1 are relatively longer than the hours in Table 21.

---

[1] The difference in locations does not affect this conclusion.

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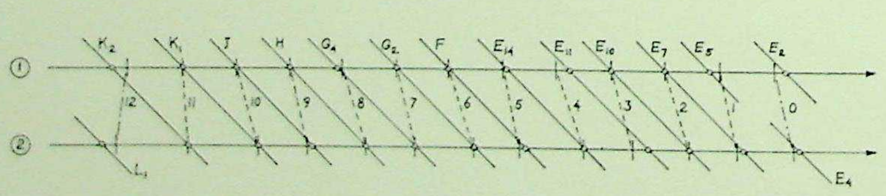
TABLE 2

(Plates 10, 31–32)

	I ꜣḫt 16	
(0)	*tp nẖt*	[*irt iꜣby*]
(1)	*nḥbt.f*	*irt iꜣby*
(2)	*bgs.f*	*ʿḳꜣ ib*
(3)	*sḏḥ.f*	*ḳʿḥ iꜣby*
(4)	*pt.f*	*ʿḳꜣ ib*
(5)	*ʿryt*	*irt iꜣby*
(6)	*tp n ꜣpd*	*ʿḳꜣ ib*
(7)	*kft.f*	*mitt*
(8)	*sbꜣ n ḫꜣw*	*ʿḳꜣ ib*
(9)	*sbꜣ n* ⟨*sʿr*⟩	*irt iꜣby*
(10)	*tpy-ʿ sꜣḥ*	*ʿḳꜣ ib*
(11)	*sbꜣ n sꜣḥ*	*ʿḳꜣ ib*
(12)	*sbꜣ n spdt*	*ḳʿḥ wnmy*

	Table 1	Table 2
(0)	E_2 +2	E_4 +1
(1)	E_5 −2	E_7 +1
(2)	E_7 0	E_{10} 0
(3)	E_{10} 0	E_{11} +3
(4)	E_{11} +3	E_{14} 0
(5)	E_{14} +1	F +1
(6)	F 0	G_2 0
(7)	G_2 0	G_4 0
(8)	G_4 −1	H 0
(9)	H 0	J +1
(10)	J 0	K_1 0
(11)	K_1 0	K_2 0
(12)	K_2 −3	L_1 −3


K₂
K₁
J
H
G₄
G₂
F
E₁₄
E₁₁
E₁₀
E₇
E₅
E₂
①
②
12
11
10
9
8
7
6
5
4
3
2
0
L₁
E₄

NOTES

The vertical line for *ʿḳ3 ib* in the chart of **D** is not the central one but the next to the right. This permits the stars to be located in the main correctly, even though the target figure intrudes. As in Table 1 the stars are one line below their text because of the doubling of the beginning of the night and the first hour into one line of text.—The first three stars of **C** are misplaced one position to the left.—Very little of **B** is preserved.

0. Neither **A** nor **D** gives the location in the text but since all the other stars of **A** are correctly located it seems safe to assume that this is also the case for the first one and we may restore *ḥr irt ṯ3by*.—The star of **C** is to be shifted one position to the right to agree with **A** and **D**.

1. The star of **C** is to be shifted one position to the right.

2. The star of **C** is to be shifted one position to the right.—**D**, emend 𓆱 to 𓏴 for *bgs*.

3. In all texts 𓌙 has been miscopied in greater or less degree as 𓌘.—**D**, emend 𓂚 to 𓂛, an error through 𓋹, cf. note to **D** in Table 1, 4.—The star of **D** is off one position to the left, as the scribe wished to avoid placing it on the division line between chart and text.

4. **A**, 𓋹 is a telescoping of 𓊪𓋹. —**C**, here and in Table 4, 2 and **A** in Table 21, 12 have ○ for 𓆱 which is difficult to explain. Possibly it may stand, instead, for ⊙, cf. *Wb.* I, p. 489, 7.

5. **A**, the determinative in *Wb.* I, p. 209, 9 should be corrected to accord with the text.—The star of **D** should be shifted one position to the left.

6. The curious sign in **C** originated no doubt in the dittography exemplified by **D**.

7. All preserved texts have *mitt*, "likewise", and this sole occurrence of it throughout the tables goes far to demonstrate a common source, despite the numerous orthographical variations.

9. Emend, of course, *ʿryt* to *sʿr* in all texts.

10. **D** omits *tpy-ʿ*. The reading here, as in Table 9, 2, is *tpy-ʿ sb3 n s3ḥ* instead of the usual *tpy-ʿ s3ḥ*.

12. **D** has 𓇼 for 𓋹. The scribe has placed the star in 7 right against the figure.

COMMENTARY

In 1501 B.C. I *3ḫt* 16 was September 4 greg. The night is lengthening. When we compare Table 2 with Table 1 we see that the inner hours of both are essentially the same. Thus the ten hours from E_7 to K_2 in both are shortened by the shift from 0 to +1 of E_7, which is more than compensated for by the lengthening from −3 (12) to 0 (11) of K_2.

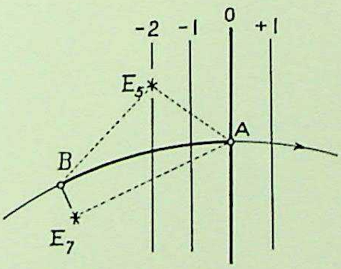


Fig. 13a

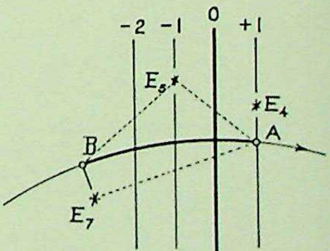


Fig. 13b

Under the rather plausible assumption that the first hour in Table 2 has at least the same length as the second hour in Table 1 we can draw some conclusions as to the relative positions of "head of the giant" (E_4) and "head of the mace of the giant" (E_5). According to Table 1 the second hour begins when E_5 is at −2 and ends when E_7 is at 0 (cf. Fig. 13a).[1] We can express this also in the following way. At the beginning of the hour a point A of the equator is in the meridian while at the end E_7 and a point B of the equator are in the meridian. Thus AB represents the length of the second hour in Table 1. We assume that 15 days later the first hour has at least the same length. According to Table 2 the first hour ends when E_7 and B are at +1, and it begins when E_4 is at +1. Thus we may say that the arc AB has at the beginning of the hour the position shown in Fig. 13b. But E_5 lies to the left of A, therefore also to the left of E_4.[2]

To be noted are the small shifts of E_{14} from +1 to 0, of F from 0 to +1, of G_4 from −1 to 0 and of J from 0 to +1.

---

[1] This figure is purely schematic and is not intended to be metrically correct.

[2] We have assumed for this argument that the vertical transit lines coincide with declination circles, although they are probably perpendicular to the horizon (*supra*, pp. 14–15). For small deviations from the meridian and for not too great altitudes the error will not affect our conclusions.

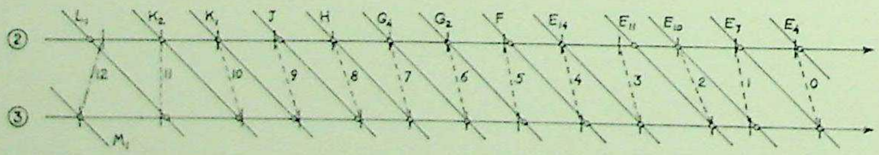
TABLE 3

(Plates 11, 33–34)

II *ꜣḫt* 1

(0)	*nḥbt nḫt*	*ꜥḳꜣ ib*
(1)	*bgs.f*	*irt iꜣby*
(2)	*sḏḥ.f*	*ꜥḳꜣ ib*
(3)	*pt.f*	*ꜥḳꜣ ib*
(4)	*ꜥryt*	*irt iꜣby*
(5)	*tp n ꜣpd*	*irt iꜣby*
(6)	*kft.f*	*ꜥḳꜣ ib*
(7)	*sbꜣ n ḫꜣw*	*ꜥḳꜣ ib*
(8)	*sbꜣ n sꜥr*	*irt wnmy*
(9)	*tpy-ꜥ sꜣḥ*	*irt wnmy*
(10)	*sbꜣ n sꜣḥ*	*irt wnmy*
(11)	*sbꜣ n spdt*	*irt iꜣby*
(12)	*tpy-ꜥ sbꜣwy*	*ꜥḳꜣ ib*

	Table 2	Table 3
(0)	E_4 +1	E_7 0
(1)	E_7 +1	E_{10} +1
(2)	E_{10} 0	E_{11} 0
(3)	E_{11} +3	E_{14} 0
(4)	E_{14} 0	F +1
(5)	F +1	G_2 +1
(6)	G_2 0	G_4 0
(7)	G_4 0	H 0
(8)	H 0	J −1
(9)	J +1	K_1 −1
(10)	K_1 0	K_2 −1
(11)	K_2 0	L_1 +1
(12)	L_1 −3	M_1 0



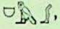
②
③
L1
K2
K1
J
H
G4
G2
F
E14
E11
E10
E7
E4
12
11
10
9
8
7
6
5
4
3
2
1
0
M1

NOTES

The first six stars of **A** and **C** are all off one position to the right.—To avoid the intruding figure as much as possible the 0 line of **D** has been located two to the right of the central vertical which permits the first six stars to be located correctly. For some unknown reason there are two stars for some hours on all charts.—In this table **D** puts the texts for 11 and 12 on one line, instead of combining 0 and 1.

0. The stars of **A** and **C** are to be shifted one position to the left.

1. *ʿḳꜣ ib* has been corrected to *ỉrt ỉꜣby* in **A**, **B** and **C** and the stars of **A** and **C** are to be shifted one position to the left.—**C** has ⌓ for 𓎛 in *bgs*.

2. **A**, emend to and shift star one position to the left.—The star in **C** is difficult to explain; possibly there is some confusion with , a disease of the leg or foot in the medical texts. The star should be shifted one position to the left.—**D**, emend to .

3. The stars of **A** and **C** are to be shifted one position to the left.—**C**, on *ḥr* see the note to Table 1, 2; emend to as in Table 1, 5.—**D**, the head of the curious sign is no doubt the hieratic for □ but the tail is inexplicable; the added stars in the chart were put in by the scribe from locations covered by the body of the target.

4. The correction added in **C** is borne out by the chart, with the shifting of **A** and **C** one position to the left, as in earlier hours, and the similar location of F in Tables 2 and 4.

5. The stars of **A** and **C** are to be shifted one position to the left.—The ⌓ after *ꜣpd* in **D** may be for 𓂋, cf. note to Table 2, 6.

6. The two stars of **A** and **C** are inexplicable.—The stars of **D** are now useless in determining positions.

7. Again the two stars of **A** and **C** are inexplicable.

8. The star of **A** should be shifted one position to the left, to agree with all texts.—It is probable that the second star of **C** was added as a correction of the same error as in **A**.

9. The star of **C** should be shifted one position to the right as also in **C**, 10–11.

10. **A** has two stars, one located properly and probably a correction.—The star of **C** should be moved one position to the right.

11. Again **A** has two stars, one located properly and probably a correction.—The determinative to *spdt* in **A** and **D** resembles that of *ʿryt* (**A**, 4) and *sʿr* (**A**, 8).—The star of **C** should be moved one position to the right, as in **C**, 9–10.

12. **A** omits its star.

COMMENTARY

In 1501 B.C. II *ꜣḫt* 1 was September 19 greg., almost the fall equinox. As expected, with lengthening night, the eleven hours from E_7 to L_1 have expanded slightly. E_7 has moved from $+1$ to 0 which begins the night one position earlier and L_1 has moved from -3 to $+1$, which ends the eleventh hour four positions later, a total gain in length of five positions. There is some inner shifting in hour length as well, the most notable of which is E_{11} from $+3$ to 0.

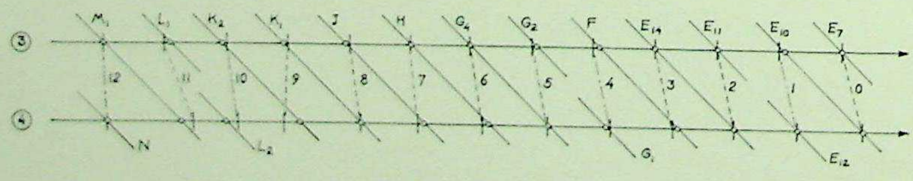
TABLE 4

(Plates 12, 35–36)

II ꜣḫt 16

(0)	*bgs nḫt*	*ꜥḳꜣ ib*
(1)	*pd nḫt*	*ꜥḳꜣ ib*
(2)	*pt.f*	*ꜥḳꜣ ib*
(3)	*ꜥryt*	*irt iꜣby*
(4)	*bꜥnt nt ꜣpd*	*irt wnmy*
(5)	*kft.f*	*ꜥḳꜣ ib*
(6)	*sbꜣ n ḫꜣw*	*irt iꜣby*
(7)	*sbꜣ n sꜥr*	*irt iꜣby*
(8)	*tpy-ꜥ sꜣḥ*	⟨*ꜥḳꜣ ib*⟩
(9)	*sbꜣ n sꜣḥ*	*ḳꜥḥ iꜣby*
(10)	*iy ḥr-sꜣ sbꜣ n spdt*	*ḳꜥḥ wnmy*
(11)	*tpy-ꜥ sbꜣwy*	*ḳꜥḥ wnmy*
(12)	*sbꜣw nw mw*	*ꜥḳꜣ ib*

	Table 3	Table 4
(0)	E_7 0	E_{10} 0
(1)	E_{10} +1	E_{12} 0
(2)	E_{11} 0	E_{14} 0
(3)	E_{14} 0	F +1
(4)	F +1	G_1 −1
(5)	G_2 +1	G_4 0
(6)	G_4 0	H +1
(7)	H 0	J +1
(8)	J −1	K_1 0
(9)	K_1 −1	K_2 +3
(10)	K_2 −1	L_2 −3
(11)	L_1 +1	M_1 −3
(12)	M_1 0	N 0


③
④
M₁
L₁
K₂
K₁
J
H
G₄
G₂
F
E₁₄
E₁₁
E₁₀
E₇
12
11
10
9
8
7
6
5
4
3
2
1
0
N
L₂
G₁
E₁₂

NOTES

D has 0 and 1 on one line again with the stars in the line below the relevant text.

0. **A** and **C** have 𓏏 for 𓋴 in *bgs.*

1. **D**, emend 𓊪𓈖 to 𓊪𓂋, and —•— to — with resulting dittography, or possibly read *pd n nḫt.*

2. **C**, on the determinative of *pt* see the note to **C** in Table 2, 4.—The curious writing in **D** may be based on the reversal of ⁓— and ⌣— as in **A**, with then another group 𓏏𓏤 added after ⌣— as occurs for example in **D**, Table 2, 4.

3. The two stars of **D** probably represent the correction of an error.

4. In **A** and **D** the combination ╤ has been misunderstood as *‘b* and the determinative of *b‘nt* ⸮ altered to ⌊.—**A**, emend *ỉꜣby* to *wnmy.*—**C**, on the determinative of *ꜣpd* see the note to **C**, Table 2, 6.

5. Here and below the stars of **D** are valueless as evidence.

7. **D**, 𓏏 has been added through confusion with *‘ryt.*

8. What follows *sꜣḥ* in all texts is undoubtedly copied from 7. Therefore we prefer to accept the position of the star which in every chart requires *‘ḳꜣ ib.*

10. In **A** and **D** ⌓ for Δ is a possible error through hieratic; both omit *ḥr* before *sꜣ.*—**A** must be emended to read *wnmy* after *ḳ‘ḥ.*

11. **A**, emend 𓋴𓏏 to 𓋴\\, an error through hieratic.—**C**, emend *ỉꜣby* to *wnmy* to agree with star and **A**, **D**.—**D**, the tip of 𓋴 is preserved, making the reading certain.

COMMENTARY

In 1501 B.C. II *ꜣḫt* 16 was October 4 greg. The still lengthening night begins with a shift of E_{10} from +1 to 0, one position earlier. M_1, however, which now ends 11 has also shifted ahead, from 0 to −3, a net shortening of eleven hours by two positions. We can be sure that this was more than compensated for by an overlong 12, since in Table 7, as we shall see, the interval between M_1 and N was split into two hours.

There are curious adjustments or changes in Table 4. There seems little reason why E_{11} at 0 should change to E_{12}, also 0, with E_{14} at 0 following in both tables. An error might be expected were it not that Table 5 also has E_{12}.

An equally curious change is from G_2 at +1 to G_1 at −1 when in both tables F at +1 precedes and G_4 at 0 follows. "Beak" (G_1) and "head" (G_2) of the bird must be close together and we would think that a shift in position of the latter could accommodate any required adjustment.

Small shifts occur in H, J and K_1 before the major ones of K_2 from −1 to +3 and M_1 from 0 to −3. The resultant shortening of the interval between K_2 and M_1 by seven positions is remarkable and strongly suggestive of a copyist error in M_1, in taking the location of L_2 for it instead of a more reasonable 0 as in Table 3 and again in Table 5. Since both texts and stars confirm −3 for M_1, however, we must accept it.

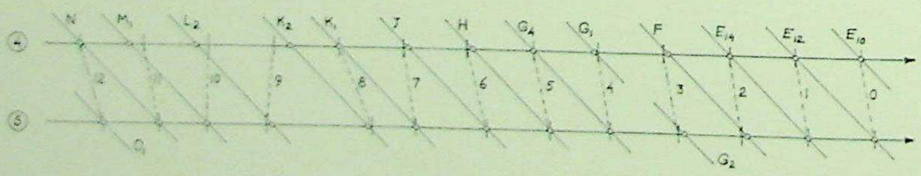
TABLE 5

(Plates 13, 37–38)

III *ꜣḫt* 1

(0)	*pd nḫt*	*ꜥḳꜣ ib*
(1)	*pt.f*	*ꜥḳꜣ ib*
(2)	*ꜥryt*	*irt iꜣby*
(3)	*tp n ꜣpd*	*irt iꜣby*
(4)	*ḫft.f*	*ꜥḳꜣ ib*
(5)	*sbꜣ n ḫꜣw*	*ꜥḳꜣ ib*
(6)	*sbꜣ n ⟨sꜥr⟩*	*ꜥḳꜣ ib*
(7)	*tpy-ꜥ sꜣḥ*	*ꜥḳꜣ ib*
(8)	*sbꜣ n sꜣḥ*	*irt wnmy*
(9)	*ty ḥr-sꜣ sbꜣ n spdt*	*irt iꜣby*
(10)	*tpy-ꜥ sbꜣwy*	*ꜥḳꜣ ib*
(11)	*sbꜣw nw mw*	*ꜥḳꜣ ib*
(12)	*tp n mꜣi*	*ꜥḳꜣ ib*

	Table 4	Table 5
(0)	E_{10} 0	E_{12} 0
(1)	E_{12} 0	E_{14} 0
(2)	E_{14} 0	F +1
(3)	F +1	G_2 +1
(4)	G_1 −1	G_4 0
(5)	G_4 0	H 0
(6)	H +1	J 0
(7)	J +1	K_1 0
(8)	K_1 0	K_2 −1
(9)	K_2 +3	L_2 +1
(10)	L_2 −3	M_1 0
(11)	M_1 −3	N 0
(12)	N 0	O_1 0


N
M₁
L₂
K₂
K₁
J
H
G₄
G₁
F
E₁₄
E₁₂
E₁₀
④
⑤
12
11
10
9
8
7
6
5
4
3
2
1
0
O₁
G₂

NOTES

Table 5 was omitted in its entirety in **C**.—The star chart of **D** almost certainly belongs to Table 6 as nothing fits here.

0. **A**, emend 𓂝 to 𓂧; 𓏏 may be superfluous or represent the phonetic shift of *d* to *t*; the twelve dots are inexplicable.—**D**, ⌈t is no doubt for ✎.

4. **A**, emend ı to 𓎛.

6. Emend *ꜥryt* to *sꜥr*, as in Table 2, 9.

9. **A**, as in Table 4, 10 𓂧 is to be emended to 𓂻.

12. The determinative of *mꜣi* in **A** (also in Table 10, 12 for *rrt*) is surely based on the hieratic rendering of ꝶ under Amenhotep III and IV (Möller, *Hier. Pal.* II, no. 166 and *ZÄS* 56 (1920), Tafel II, after p. 40) and this confirms the Eighteenth Dynasty origin of this present type of star clock. For additional evidence of this origin see the notes to Table 6, 10 and Table 7, 0.—The determinative in **D** arose as a hieroglyphic transmission error from the hieratic error of **A**.

COMMENTARY

In 1501 B.C. III *ꜣḫt* 1 was October 19 greg. The nights are still growing longer but there is no change in the length of the last eleven hours of Table 4 and the first eleven hours of Table 5. The increase in length must again, just as in Table 4, be found in an overlong twelfth hour (N at 0 to O_1 at 0).

The inner hours again exhibit unexpected changes. G_1 at −1 gives way to G_2 at +1, though in both tables F at +1 precedes and G_4 at 0 follows. This is the reversal of the change from G_2 to G_1 which occurred in Table 4.

K_2 shifts from +3 to −1 and is followed by L_2 moving from −3 to +1 and M_1 from −3 to 0. The hour between K_2 and L_2 has thus lengthened appreciably and that between M_1 and N has shortened.

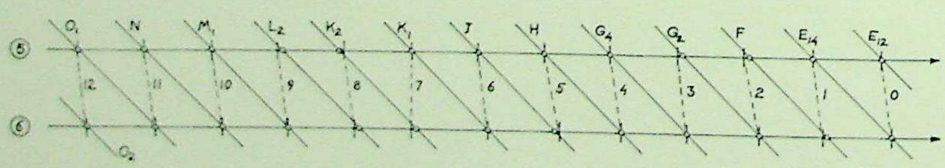
TABLE 6

(Plates 14, 38–40)

III ꜣḫt 16

(0)	*pt* ⟨*nḫt*⟩	*ꜥḳꜣ ib*
(1)	*ꜥryt*	*irt iꜣby*
(2)	*tp n ꜣpd*	*ꜥḳꜣ ib*
(3)	*kft.f*	*ꜥḳꜣ ib*
(4)	*sbꜣ n ḫꜣw*	*ꜥḳꜣ ib*
(5)	*sbꜣ n sꜥr*	*irt wnmy*
(6)	*tpy-ꜥ sꜣḥ*	*ꜥḳꜣ ib*
(7)	*sbꜣ n sꜣḥ*	*irt iꜣby*
(8)	*iy ḥr-sꜣ spdt*	*irt iꜣby*
(9)	*tpy-ꜥ sbꜣwy*	*ꜥḳꜣ ib*
(10)	*sbꜣw nw mw*	*ꜥḳꜣ ib*
(11)	*tp n mꜣi*	*ꜥḳꜣ ib*
(12)	*sd.f*	*ꜥḳꜣ ib*

	Table 5	Table 6
(0)	E_{12} 0	E_{14} 0
(1)	E_{14} 0	F +1
(2)	F +1	G_2 0
(3)	G_2 +1	G_4 0
(4)	G_4 0	H 0
(5)	H 0	J −1
(6)	J 0	K_1 0
(7)	K_1 0	K_2 +1
(8)	K_2 −1	L_2 +1
(9)	L_2 +1	M_1 0
(10)	M_1 0	N 0
(11)	N 0	O_1 0
(12)	O_1 0	O_2 0


O1
N
M1
L2
K2
K1
J
H
G4
G2
F
E14
E12
⑤
⑥
12
11
10
9
8
7
6
5
4
3
2
1
0
O2

NOTES

In the charts of **A**, **B** and **C** the line for *ʿḳꜣ ib* is the one to the right of the central line. The chart for **D** as given is useless but the one for **D** in Table 5 can be used here, with the proviso that the *ʿḳꜣ ib* line be taken as the second to the right of the central one.—**C** has two copies of the text flanking one chart. Pl. 14 gives two photographs of **C**$_1$ (see *supra*, p. 2) but neither reflects what can actually be seen on the ceiling.

0. **A**, we expect *nḫt* after *pt* or, less probably, *pt.f.*—**D**, emend *pd* to *pt* (as also in Table 24, 7).

2. In **C**$_1$ there is space for only 𓅯𓊪 or 𓊪𓅯 so that, as in **C**$_2$, *tp n* must be emended.

3. **A**, emend 𓐍 to 𓎛.—**C**$_1$ omits 𓆑. There is only one space in which the star may go and that is the correct one.—**D** omits 𓏏𓎛 in *kft*.

5. The stars of **A**, **B** and **D** are at *irt wnmy* as also the text of **B** and **D**. Emend, therefore, *iꜣby* to *wnmy* in **A** and **C**. The error may very well have arisen through confusion with hour 1 of this table which has *ʿryt* at *irt iꜣby*. Confusion with *ʿryt* is noticeable in the 𓏏 added in **A**, the borrowed determinative and 𓇌 in **B**, 𓇌𓏏 in **C**. and *ʿrt* for *sʿr* in **D**.—The star of **C** is to be moved one position to the left. It has probably changed places with the one in the next line.

6. **C**, the star should be shifted one position to the right; see note to 5.

7. The two stars in **C** are a correction and an error.

8. **A**, emend 𓆓 to Λ; cf. note to Table 4, 10.—As in 5 and 6 the stars of 8 and 9 of **C** seem to have interchanged. The star here should be shifted one position to the right.—**D**, the star positions are no longer usable because of the target figure. —All texts omit *sbꜣ n*.

9. **A**, 𓎛𓏏 is an error through the hieratic for 𓎛𓏭.—The star of **C** should be shifted one position to the left; see note to 8, **C**.

10. **C** has 𓇼𓏤 for 𓇼𓏥, a frequent error through the hieratic which is another indication of an Eighteenth Dynasty origin (see Möller, *Hier. Pal.* II, no. 561). It is interesting that **C** did not follow the version of **A**, which is correct. They both must have used an earlier hieratic text, which **C** misinterpreted.

11. See the note to Table 5, 12. **C**$_1$ has added the correct determinative 𓊃 to the misinterpretation of the hieratic sign. —**C**$_2$ omits — and has probably added 𓈙 as a further misinterpretation of 𓊛 as the mooring-post determinative of the star 𓈙𓇋𓏏𓊛 which first appears in Table 8, 12, *q.v.*

COMMENTARY

In 1501 B.C. III *ꜣḫt* 16 was November 3 greg. The night is still growing longer but the extra length must be concentrated in the twelfth hour since the interval from 0 to 11 has the same length as in Table 5. There are small shifts, G$_2$ from +1 to 0, J from 0 to −1, K$_2$ from −1 to +1, but no change in hour stars.

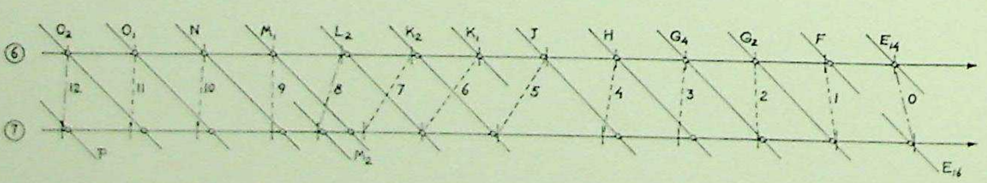
TABLE 7

(Plates 15, 41–42)

IIII *ꜣḫt* 1

(0)	*sbꜣ n sꜣ pt*	⟨*irt*⟩ *wnmy*
(1)	*tp n ꜣpd*	*irt wnmy*
(2)	*kft.f*	*irt iꜣby*
(3)	*sbꜣ n ḫꜣw*	*ḳꜥḥ iꜣby*
(4)	*sbꜣ n sꜥr*	*ḳꜥḥ iꜣby*
(5)	*sbꜣ n sꜣḥ*	*irt wnmy*
(6)	*iy ḥr-sꜣ* ⟨*sbꜣ*⟩ *n spdt*	*ꜥḳꜣ ib*
(7)	*tpy-ꜥ sbꜣwy*	*ḳꜥḥ wnmy*
(8)	*sbꜣwy*	*irt iꜣby*
(9)	*sbꜣw nw mw*	*msḏr iꜣby*
(10)	*tp n mꜣi*	*ḳꜥḥ iꜣby*
(11)	*sd.f*	*ḳꜥḥ iꜣby*
(12)	*sbꜣw ꜥšꜣw*	*irt iꜣby*

	Table 6	Table 7
(0)	E_{14} 0	E_{16} -1
(1)	F $+1$	G_2 -1
(2)	G_2 0	G_4 $+1$
(3)	G_4 0	H $+3$
(4)	H 0	J $+3$
(5)	J -1	K_2 -1
(6)	K_1 0	L_2 0
(7)	K_2 $+1$	M_1 -3
(8)	L_2 $+1$	M_2 $+1$
(9)	M_1 0	N $+2$
(10)	N 0	O_1 $+3$
(11)	O_1 0	O_2 $+3$
(12)	O_2 0	P $+1$


O2
O1
N
M1
L2
K2
K1
J
H
G4
G2
F
E14
⑥
12
11
10
9
8
7
6
5
4
3
2
1
0
⑦
P
M2
E16

NOTES

The charts of **A** and **C** (and presumably **B** also though only one star is preserved) have a common error in that the star for 2 is an intruder which displaces the following stars. It is necessary to advance all stars from 3 to 12 up one line and this gives complete agreement with the text. There is then no star for 12.

0. All texts have the hieratic sign for □ as though the scribe were uncertain how to read it. The form is much more the earlier than the later, current one (*cf.* Möller, *Hier. Pal.* II, no. 388, and the discussion by J. J. Clère in *JEA* 25 (1939), pp. 22, 27 on the confusion between the hieratic of □ and 𓉔) and is confirmatory evidence of the Eighteenth Dynasty origin of the text. See also the note to Table 5, 12.—All texts also omit a location before *wnmy*, which on the basis of the charts should be *irt*.—The stroke after *ꜣḫt* in **A** could conceivably be for "day 1", but it does not appear in other tables.—**B**, from the traces, follows **A** closely, with the stroke after *ꜣḫt* and the omission of *irt*.—**C** has 𓄤 for 𓁷𓏤, which is difficult to explain, and omits 𓁶𓏤 as well as *irt*.

1. The two preserved stars are at *irt wnmy* and it should be observed that, with the adjustment noted above, all the stars of this table are located correctly. **A** has an uncorrected *ʿḳꜣ ib* but **B** and **C** both add a correction to an uncertain *irt*. The traces in **B** do not rule out 𓋹 but are also suitable for 𓄤. **C** has *iꜣby* but in 5 below also has *iꜣby* where *wnmy* is clearly correct. It seems best to accept the position of the stars and emend the *iꜣby* of **C** to *wnmy*.—There is room in **B** for an abbreviated rendering of *r ʿḳꜣ ib* before *irt*.—**C**, the two strokes after *tp* are no doubt for *y*.

2. The star is that of the third hour on the charts. This moving up is followed through the remaining hours to 12 without comment.—**C**, on *ḥr* see the note to Table 1, 2. The location *r ʿḳꜣ ib* is surely an error, judging from the stars and the text of **A**. It is possible that the correction in **C**, 1 was intended for this line where it would have been appropriate.

3. When the scribe of **C** uses a space rather than a line to locate the star he may place it to either side of the correct vertical. Here he has put it in the space to the left, just as in 6 he places a star at *ʿḳꜣ ib* to the left of center. Elsewhere, Table 6 for example, he has tended to use the space to the right of the correct vertical.

4. The 𓏏 in **A** and **C** is through the usual confusion with *ʿryt*.

5. **C**, emend *iꜣby* to *wnmy* to agree with **A** and the position of the stars.

6. **A**, as in Tables 4 to 6, 𓈙 is an error for 𓂻, possibly through the hieratic. The scribe omitted 𓇼𓏤 before *spdt*.—**C**, *sꜣ* without *ḥr* was crowded in as an afterthought.

7. **A** omits the hour numeral and has 𓎛𓏏 for 𓎛𓏭.—**C**, 𓇼𓏤𓁷𓏤 may be a misreading of 𓇼𓇼𓎛𓏭 (as in 8) with a following *ḥr* then omitted.

9. **A**, emend 𓎛𓏭 to 𓏤𓏤𓏤𓏤.—**C** has 𓇼𓏤 for 𓇼𓏤𓏤𓏤𓏤; *cf.* note to Table 6, 10. The star for this hour has been placed to the right of the vertical; see note to 3 above. This is true also of the stars of **C** in 10 and 11.

10. **A** and **C**, on the determinative of *mꜣt* see the notes to Tables 5, 12 and 6, 11.

12. As remarked above there is no star for this hour because of the erroneous one for 2 and the necessary shifting upward of the succeeding stars. **A** has *wnmy* with no location while **C** gives *irt iꜣby*. It is preferable to follow **C** since this star jumps an hour in Table 8 where it is at 0 and this suggests a + position here; see the discussion below.—As in 9 above, **C** is to be emended to 𓇼𓏤𓏤𓏤𓏤.

COMMENTARY

In 1501 B.C. IIII *ꜣḫt* 1 was November 18 greg. The night is still growing longer. The inner ten hours from G_2 at 0 to O_2 at 0 of Table 6 have expanded by four positions to G_2 at −1 and O_2 at +3. It is probable that the first hour of Table 7 is longer than the second hour of Table 6, since for *ʿryt* (F) of Table 6 is substituted the last star of the constellation of the giant (E_{16}) and there is a shift to an earlier position as well, from +1 to −1.

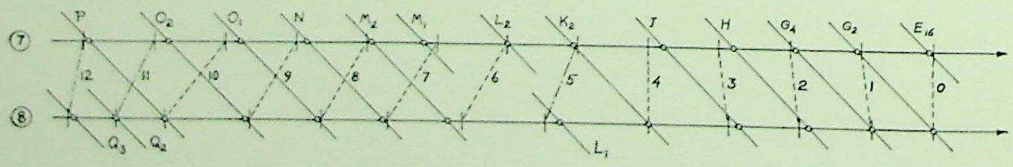
In Table 7 we encounter the first instance of the dropping of one hour star and the introduction of another hour star at some distance from the former with considerable positional shifting of hour boundaries in compensatory adjustment. This is best seen in the diagram. K_1 is the star which drops out. The three before it shift increasingly toward + positions while the three which follow it and which jump an hour all shift in the opposite direction. The result is that when K_1 drops from between J and K_2 the hour boundaries shift closer together by six positions. Similarly when M_2 is introduced as a new hour star after M, the three following hour boundaries all shift in a + direction and those for M_1 and N have moved farther apart by five positions.

TABLE 8

(Plates 16, 42–43)

	IIII ꜣḫt 16	
(0)	*tp n ꜣpd*	*ꜥḳꜣ ib*
(1)	*kft.f*	*ꜥḳꜣ ib*
(2)	*sbꜣ n ẖꜣw*	*msḏr iꜣby*
(3)	*sbꜣ n sꜥr*	*msḏr iꜣby*
(4)	*sbꜣ n sꜣḥ*	*ꜥḳꜣ ib*
(5)	*sbꜣ n spdt*	*ḳꜥḥ iꜣby*
(6)	*sbꜣwy*	*ḳꜥḥ ⟨wnmy⟩*
(7)	*sbꜣw nw mw*	*irt wnmy*
(8)	*tp n mꜣi*	*irt wnmy*
(9)	*sd.f*	*irt wnmy*
(10)	*sbꜣw ꜥšꜣw*	*ꜥḳꜣ ib*
(11)	*ṯꜣ nfr*	*ꜥḳꜣ ib*
(12)	*šmsw n ḥꜣt ⟨n⟩ mnit*	*irt iꜣby*

	Table 7	Table 8
(0)	E_{16} −1	G_2 0
(1)	G_2 −1	G_4 0
(2)	G_4 +1	H +2
(3)	H +3	J +2
(4)	J +3	K_2 0
(5)	K_2 −1	L_1 +3
(6)	L_2 0	M_2 −3
(7)	M_1 −3	N −1
(8)	M_2 +1	O_1 −1
(9)	N +2	O_2 −1
(10)	O_1 +3	P 0
(11)	O_2 +3	Q_2 0
(12)	P +1	Q_3 +1


⑦
⑧
P
O₂
O₁
N
M₂
M₁
L₂
K₂
J
H
G₄
G₂
E₁₆
12
11
10
9
8
7
6
5
4
3
2
1
0
Q₃
Q₂
L₁

NOTES

3. **C**, as frequently, 𓏏 is added through confusion with *ʿryt*.

4. **A**, the hour numeral has been squeezed in as a correction.—**B** has 𓂻 in *ʿḳꜣ* through confusion with *ʿḳ* "to enter"; see also *RdE* 6 (1951), p. 142, L.

5. **C** omits *spdt*; 𓂋 between *ḳʿḥ* and *ỉꜣby* is very doubtful and the space may be blank.

6. All texts and charts agree on *ḳʿḥ ỉꜣby* but the fact that *sbꜣwy* skips an hour makes it certain that an emendation to *wnmy* be made. See the commentary to Table 7 and below.

7. **C** shows confusion with *sbꜣwy* and has *ỉꜣby* for the surely correct *wnmy*, witnessed by the stars and **A** and **B**.

8. On the determinatives of *mꜣỉ* see the note to Table 5, 12.—**C** again has *ỉꜣby* for *wnmy*, attested by the stars and **A**.

10. **C**, the scribe probably corrected $\underline{\star}^{\prime}$ of Table 7, 12 by dropping — instead of reading it as 𓏥.

12. **A**, it is likely that 𓏥 is here a hieratic error for — (the reverse of Table 6, 10); *r ʿḳꜣ ỉb* should be emended to *ḥr ỉrt ỉꜣby* to agree with the stars and **C**. The form of the determinative of the mooring post derives from the hieratic; cf. Möller, *Hier. Pal.* II, no. 454, 3.

COMMENTARY

In 1501 B.C. IIII *ꜣḫt* 16 was December 3 greg. The night is still lengthening, and it is possible to demonstrate this by a comparison of Table 8 with 7. G_2, which begins the night, has moved from −1 to 0, a small delay which suggests that as the first hour star in Table 7 it ended the hour too quickly. However, where Table 7 has three hours from K_2 to M_2 Table 8 has but two. L_2 and M_1 have dropped out and only L_1 has replaced them. The situation is shown in the diagram. In Table 8 the hour boundaries of K_2 and M_2 are closer together by five positions but this cannot be full compensation for the hour loss. P at +1, which ended 12 in Table 7, now ends 10 at 0 and two new stars have to be added to mark the ends of 11 and 12 for Table 8. While these last must be relatively short hours, there can be no doubt that the night as a whole is longer.

The diagram also shows clearly why the emendation for M_2 from *ỉꜣby* to *wnmy* is required. The star has to end its hour earlier than before because of the change from three to two hours immediately before it. Moreover, all three stars following M_2 shift their hour boundaries by three or four positions from left to right.

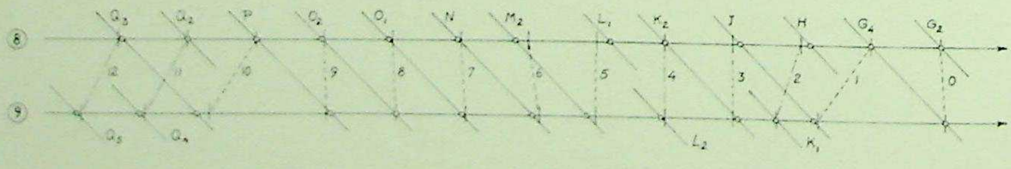
TABLE 9

(Plates 17, 44–45)

I *prt* 1

(0)	*kft.f*	*ꜥḳꜣ ib*
(1)	*sbꜣ n sꜥr*	*irt wnmy*
(2)	*tpy-ꜥ sbꜣ n sꜣḥ*	*ꜥḳꜣ ib*
(3)	*sbꜣ n sꜣḥ*	*irt iꜣby*
(4)	*iy ḥr-sꜣ* ⟨*sbꜣ*⟩ *n spdt*	*irt wnmy*
(5)	*sbꜣwy*	*msḏr wnmy*
(6)	*sbꜣw nw mw*	*msḏr wnmy*
(7)	*tp n mꜣi*	*irt wnmy*
(8)	*sd.f*	*ꜥḳꜣ ib*
(9)	*sbꜣw ꜥšꜣw*	⟨*irt iꜣby*⟩
(10)	*šmsw ḥꜣt n mnit*	⟨*ḳꜥḥ*⟩ *wnmy*
(11)	*mnit*	*irt wnmy*
(12)	*šmsw n mnit*	*irt wnmy*

	Table 8	Table 9
(0)	G_2 0	G_4 0
(1)	G_4 0	J −1
(2)	H +2	K_1 0
(3)	J +2	K_2 +1
(4)	K_2 0	L_2 −1
(5)	L_1 +3	M_2 −2
(6)	M_2 −3	N −2
(7)	N −1	O_1 −1
(8)	O_1 −1	O_2 0
(9)	O_2 −1	P +1
(10)	P 0	Q_3 −3
(11)	Q_2 0	Q_4 −1
(12)	Q_3 +1	Q_5 −1



Q_3
Q_2
P
O_2
O_1
N
M_2
L_1
K_2
J
H
G_4
G_2
⑧
12
11
10
9
8
7
6
5
4
3
2
1
0
⑨
Q_5
Q_4
L_2
K_1

NOTES

In **B** either the 0 or 1 line has been omitted since the actual second line of the table is for 2 and so on.

0. **A** omits *grḥ*.

4. **A**, **C** and probably **B** omit 𓇼. In **A** the — which should precede 𓈎 has been misplaced and follows.

5. **A**, the stroke above ✎ is more likely to be part of the writing of 𓊪 than a 𓏏.

6. **A**, see the note to 5.—**C**, as in Tables 6 and 7 emend to 𓇼𓏥; *wnmy* has been omitted.

7. On the determinatives of *mꜣi* see the note to Table 5, 12.

9. The preserved stars are at *irt iꜣby*, the preserved texts give *ʿkꜣ ib*. It seems preferable here to take the evidence of the stars and emend the text, since, as shown in the diagram, the inclination of the hour boundary of P should be to the left, with Q$_2$ dropping out between P and Q$_3$ and the hour boundary of the latter moving four positions to the right. With this should be compared the diagram and commentary to Table 7.—**C**, see the note to Table 8, 10.

10. It is almost certain that *ḳʿḥ* is to be added to **A** to agree with the stars of **A** and **C** rather than *irt* as in **C**. This star skips an hour and as its hour boundary was at *irt iꜣby* a shift to *ḳʿḥ wnmy* seems mandatory. See the commentary to Table 7 and the discussion below.—On the confusion in writing the star's name see the note to Table 8, 12.

11. **A**, the star at 0 may have been drawn first in error, or it may conceivably be a misplaced and erroneous correction to **A**, 9 above.

12. **C**, *ḥꜣt* is through analogy with Q$_3$ in 10 and ı ı ı is no doubt for — (cf. Table 8, 12).

COMMENTARY

In 1501 B.C. I *prt* 1 was December 18 greg. Table 9 must then take in the longest night of the year, and a comparison of Table 8 with Table 9 (and of Table 9 with Table 10, *infra*, p. 38) bears this out. With the dropping of Q$_2$ the eleven hours from G$_4$ to Q$_3$ of Table 8 become only ten hours in Table 9, and this is hardly compensated for by the shift to the right of the hour boundary of Q$_3$ by four positions, even though Q$_2$ and Q$_3$ must have marked relatively short hours. Two hours, again no doubt relatively short, are needed for 11 and 12 in Table 9.

The diagram shows the adjustments between the tables and illustrates the difficulties of interpretation. Between G$_4$ and M$_2$ there are five hours in each table, yet there is great exchange of stars. Besides the substitution of L$_2$ for L$_1$, H drops out between G$_4$ and J, and K$_1$ is introduced between J and K$_2$. This can be seen best by a comparison with the diagram to Table 7. In Table 6 the stars were G$_4$, H, J, K$_1$ and K$_2$. In Table 7 K$_1$ had been dropped to reduce the four hours to three. In Table 9 we still have three hours, but it is as though the dropping out of K$_1$ had never taken place and H had been dropped instead. Fig. 14 shows the result of comparing Table 6 and Table 9. It is clear that the hour from G$_4$ to J is now a long hour indeed.

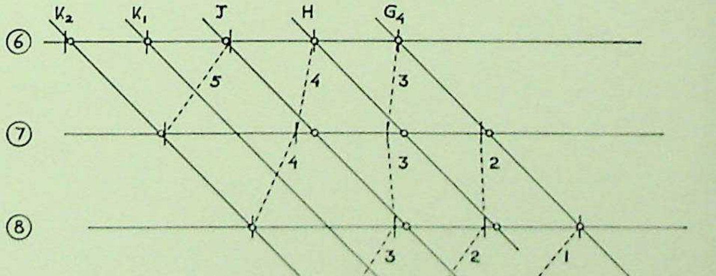


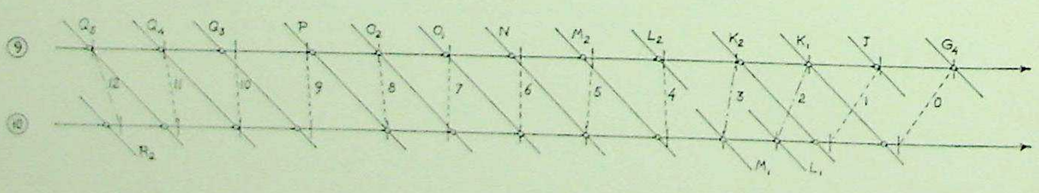
Fig. 14

TABLE 10

(Plates 18, 45–46)

	I *prt* 16	
(0)	*tpy-ꜥ sꜣḥ*	*⟨ḳꜥḥ⟩ wnmy*
(1)	*sbꜣ n sꜣḥ*	*ḳꜥḥ wnmy*
(2)	*sbꜣ n spdt*	*ꜥḳꜣ ib*
(3)	*tpy-⟨ꜥ⟩ sbꜣwy*	*ꜥḳꜣ ib*
(4)	*sbꜣwy*	*msḏr wnmy*
(5)	*sbꜣw nw mw*	*ꜥḳꜣ ib*
(6)	*tp n mꜣi*	*ꜥḳꜣ ib*
(7)	*sd.f*	*irt iꜣby*
(8)	*sbꜣw ꜥšꜣw*	*ꜥḳꜣ ib*
(9)	*šmsw ḥꜣt n mnit*	*ḳꜥḥ wnmy*
(10)	*mnit*	*irt wnmy*
(11)	*šmsw mnit*	*ḳꜥḥ wnmy*
(12)	*pd n rr⟨t⟩*	*ḳꜥḥ wnmy*

	Table 9	Table 10
(0)	G_4 0	K_1 −3
(1)	J −1	K_2 −3
(2)	K_1 0	L_1 0
(3)	K_2 +1	M_1 0
(4)	L_2 −1	M_2 −2
(5)	M_2 −2	N 0
(6)	N −2	O_1 0
(7)	O_1 −1	O_2 +1
(8)	O_2 0	P 0
(9)	P +1	Q_3 −3
(10)	Q_3 −3	Q_4 −1
(11)	Q_4 −1	Q_5 −3
(12)	Q_5 −1	R_2 −3


⑨
⑩
Q5
Q4
Q3
P
O2
O1
N
M2
L2
K2
K1
J
G4
12
11
10
9
8
7
6
5
4
3
2
1
0
R2
M1
L1

NOTES

C has only the star chart. **B** has completely disappeared.

0. **A**, it is uncertain whether the doubtful sign after *nt* is for ○ or □; *tp grḥ* has been omitted. It seems advisable to take the location of the stars at *ḳʿḥ wnmy* as correct rather than the text's *msḏr*. The star K_1 skips an hour and the hour boundary should shift as far as possible to the left of 0.

3. 𓂋𓏤 has been omitted.

6. On the determinative of *mnit* see the note to Table 5, 12.

9. The hour numeral has been omitted; ı ı ı is probably for a redundant — (see the note to Table 8, 12). The star of **A** probably belongs to the next hour, which is blank.

10. **A** has no star, unless it be out of place in 9, and the star of **C** has been placed by the scribe in the space which he has been using for *ʿḳꜣ ib*, to the right instead of the left of the correct vertical.

11. **C** has two stars, on either side of the line, and the left one must be a correction.

12. **A**, emend the stroke under 𓂋𓂋 to 𓏏 and on the determinative, an error for 𓊹, see the note to Table 5, 12.

COMMENTARY

In 1500 B.C. I *prt* 16 was January 2 greg. The night ought, accordingly, to begin to shorten and there is clear indication that Table 10 is, indeed, shorter than its predecessor. The ten hours from K_1 to Q_5 of Table 9 have increased to eleven in Table 10 with the replacement of L_2 by L_1 and the introduction of M_1, as shown in the diagram, and the whole time span has lengthened by but one position (K_1 moves from 0 to -3 and Q_5 from -1 to -3). The one new hour (Q_5–R_2), while it may be long, can hardly be equal to the two of G_4–J–K_1 in Table 9, especially when we recall that G_4 to J was an exceptionally long hour by itself (commentary to Table 9).

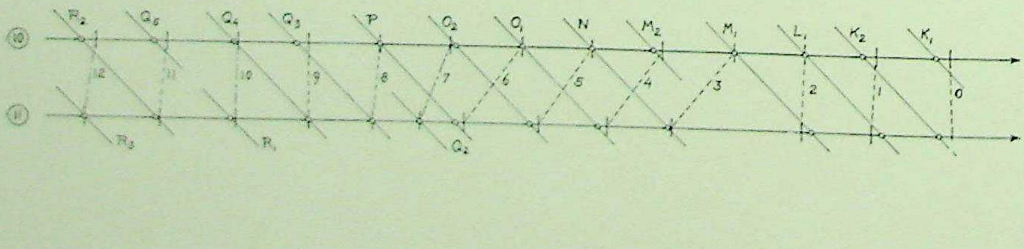
This turn toward a shorter night confirms in the clearest possible way the accuracy of the date ascribed to the construction of the star clocks as the early Eighteenth Dynasty.

TABLE 11

(Plates 18, 46–47)

	II *prt* 1	
(0)	*sbꜣ n sꜣḥ*	*ḳꜥḥ wnmy*
(1)	*sbꜣ n spdt*	*msḏr iꜣby*
(2)	⌜⟨*tpy-ꜥ*⟩⌝ *sbꜣwy*	*msḏr* ⌜*iꜣby*⌝
(3)	*sbꜣw nw mw*	*irt wnmy*
(4)	*tp n mꜣi*	*msḏr wnmy*
(5)	*sd.f*	*msḏr wnmy*
(6)	*sbꜣ* ⟨*w ꜥšꜣw*⟩	⟨*msḏr wnmy*⟩
(7)	*ṯꜣ nfr*	*ꜥḳꜣ ib*
(8)	*šmsw* ⟨*n*⟩ *ḥꜣt mnit*	*ꜥḳꜣ ib*
(9)	⟨*mnit*⟩	*ꜥḳꜣ ib*
(10)	*rd n rrt*	*irt wnmy*
(11)	*pd.s*	*irt wnmy*
(12)	⟨*ḥry-ib*⟩ *mnty.s*	*ꜥḳꜣ ib*

	Table 10	Table 11
(0)	K_1 −3	K_2 −3
(1)	K_2 −3	L_1 +2
(2)	L_1 0	M_1 +2
(3)	M_1 0	N −1
(4)	M_2 −2	O_1 −2
(5)	N 0	O_2 −2
(6)	O_1 0	P −2
(7)	O_2 +1	Q_2 0
(8)	P 0	Q_3 0
(9)	Q_3 −3	Q_4 0
(10)	Q_4 −1	R_1 −1
(11)	Q_5 −3	R_2 −1
(12)	R_2 −3	R_3 0


R₂
Q₅
Q₄
Q₃
P
O₂
O₁
N
M₂
M₁
L₁
K₂
K₁
⑩
⑪
12
11
10
9
8
7
6
5
4
3
2
1
0
R₃
R₁
Q₂

NOTES

A has the correct star chart throughout but 5 to 12 inclusive of the text are a duplicate of Table 12 and are given there as a second version. **B** has completely disappeared.

2. The two stars and the text of **A** all agree, which suggests that we should emend *ỉꜣby* of **C** to *wnmy* and also emend ★ꜝ to *sbꜣwy*. This would mean that the star jumps an hour without shifting the hour boundary to the right, and this would be unusual, though not impossible. However, Table 12 has *sbꜣwy* at 2 and that rules it out here. We must, therefore, take ★ꜝ of **C** as a hieratic error for ⊙ꜝ, emend to *tpy-ꜥ sbꜣwy* and accept **C**'s *msḏr ỉꜣby* which would mean that M_2 would be the star dropping out, with the hour boundaries of M_1 and N moving three positions closer together.—**C** consistently omits *ḥr* in 2 to 5.

3. **C** omits ı ı ı.

4. On the determinatives of *mꜣt* see the note to Table 5, 12.—**C** omits —.

5. From here to 12 the text of **A** belongs to Table 12.

6. The only possible reading is *sbꜣw ꜥšꜣw* but there is no simple explanation for the signs in the text beyond the fact that — may easily stand for ı ı ı and ♀ be a reminiscence of *sbꜣw nw mw* in 3. Since *sbꜣw ꜥšꜣw* has also skipped an hour it is strange that its position has not altered and this casts some doubt on the correctness of the text outside of the name of the star. If we now look at 9 we find that the star is given there as *sbꜣ ꜥšꜣw* which is what we want in 6 and though the location is given as *ꜥḳꜣ ib* the chart has the stars at *msḏr wnmy*. It is our suggestion that the stars of 9 go with *sbꜣw ꜥšꜣw* and that *ꜥḳꜣ ib* is the location of *mnit*, the required emendation for 9. This results in a shift of the hour boundary to the right of two positions, a desideratum for a star skipping an hour.

8. **C**, emend ı ı ı to —.

9. Emend to *mnit* at *ꜥḳꜣ ib* and see the note to 6.

10. Except in Table 12 **C** consistently writes *rd* instead of the dual *rdwy* favored by **A**. Though both stars agree at *ḳꜥḥ ỉꜣby* the text must be correct as the star at +3 would be delayed entirely too long after *mnit*, since *šmsw mnit* does not appear in this table.

12. **C** must be emended from *pd.s* to *ḥry-ib* but there is no question of misreading the hieratic. The error must have come about as a simple copy from 11.

COMMENTARY

In 1500 B.C. II *prt* 1 was January 17 greg. The night has begun to decrease in length. The eleven hours from K_2 to R_2 have shortened by two positions and though this may have been more than compensated for by the new hour of R_3 it is more likely that the whole twelve hours are some minutes shorter than those of Table 10.

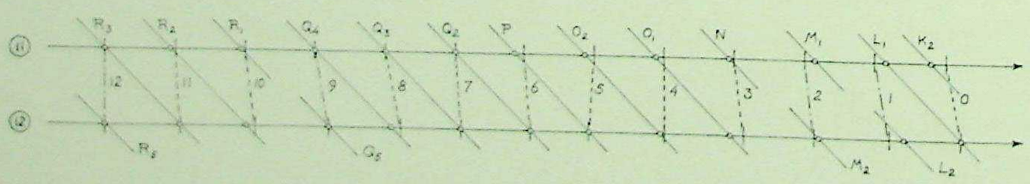
There has been considerable internal adjustment of the hours as can be seen in the diagram, which includes the emendations we propose for 2 (M_1), 6 (P) and 9 (Q_4). Their conformity to the general pattern, as shown clearly in the diagram, is, of course, an indication of their strong probability.

TABLE 12

(Plates 19, 47–48)

	II *prt* 16	
(0)	*sbꜣ n [spdt]*	*[ʿḳꜣ ib]*
(1)	*iy ⟨ḥr⟩-sꜣ spdt*	*ḳʿḥ ⟨iꜣby⟩*
(2)	*sbꜣwy*	*irt iꜣby*
(3)	*tp n mꜣi*	*ḳʿḥ wnmy*
(4)	*sd.f*	*irt wnmy*
(5)	*sbꜣw ʿšꜣw*	*ʿḳꜣ ib*
(6)	*ṯꜣ nfr*	*ʿḳꜣ ib*
(7)	*šmsw ⟨n⟩ ḫꜣt n mnit*	*ʿḳꜣ ib*
(8)	*mnit*	*msḏr wnmy*
(9)	*šmsw n mnit*	*ʿḳꜣ ib*
(10)	*⟨pd⟩ n rrt*	*msḏr wnmy*
(11)	*ḥry-ib n mn⟨ty⟩.s*	*ʿḳꜣ ib*
(12)	*ḫpd.s*	*ʿḳꜣ ib*

	Table 11	Table 12
(0)	K_2 −3	L_1 0
(1)	L_1 +2	L_2 +3
(2)	M_1 +2	M_2 +1
(3)	N −1	O_1 −3
(4)	O_1 −2	O_2 −1
(5)	O_2 −2	P 0
(6)	P −2	Q_2 0
(7)	Q_2 0	Q_3 0
(8)	Q_3 0	Q_4 −2
(9)	Q_4 0	Q_5 0
(10)	R_1 −1	R_2 −2
(11)	R_2 −1	R_3 0
(12)	R_3 0	R_5 0


⑪
⑫
R3
R2
R1
Q4
Q3
Q2
P
O2
O1
N
M1
L1
K2
12
11
10
9
8
7
6
5
4
3
2
1
0
R5
Q5
M2
L2

NOTES

Hours 5 to 12 of **A** were duplicated in Table 11, here referred to as **A**$_2$. **B** has completely disappeared.

0. There can hardly be any question that after *sbꜣ n* of **C** the restoration must be *spdt r ꜥḳꜣ ib*, the position being taken from the chart. The date in **C**, after II *prt*, is obviously corrupt.

1. **A**, ǂ is for ⊿ (cf. note to Table 4, 10); *ḥr* has been omitted before *sꜣ*.—**C** omits *ty ḥr-sꜣ* and has ⊔ for △, an easy confusion in hieratic; an original *ḥr irt* has also been corrected to *ḥr ḳꜥḥ*.—The stars of **A** and **C** and the text of **A** agree on *ḳꜥḥ wnmy*, while the correction in **C** is to *ḳꜥḥ iꜣby*. We accept this in preference to the other extreme position because this is the only table which has both L$_1$ and L$_2$ in successive hours and not as the virtual alternates they have appeared to be in Tables 2 to 11. They must be stars with transits rather close together and with L$_1$ at 0 it is essential to have the end of the hour of L$_2$ delayed to +3 in order for it to have any appreciable length.

2. **C**, ♀ is an error for ☿.

3. **A**, on the determinative of *mꜣi* see the note to Table 5, 12.—**C** exhibits the same sort of confusion between *mꜣi* and *mnit* as in **C**$_2$ of Table 6, 11 with the addition of ★♀ for *tp n*; emend *irt* to *ḳꜥḥ* as required by **A** and the stars.

4. **C**, *ḥr* has been omitted.

5. **C**, emend — to ııı (cf. Table 6, 10).

7. In all texts ııı is probably for — (see the notes to Tables 8, 12 and 10, 9).

8. **C** omits *ḥr* and the star is to be moved one position to the right to agree with the texts.

9. **C**, emend ııı to — as in 7.

10. There is no question that we must emend *rd(wy) n rrt* to *pd n rrt*, since the former is the star for 10 in Table 11. Both are determined by ʃ and confusion between 𓂋 and 𓊪 is easy (cf. Table 15, 7 for example).—**A**$_2$, on the determinative of *rrt* see the note to Table 10, 12.

11. There is obvious confusion between *mnit* and *mnty*; emend to the latter.

12. The curious writing in **C** is of course intended for ◎□𓂋.

COMMENTARY

In 1500 B.C. II *prt* 16 was February 1 greg. The night is shortening, but this cannot be detected in the shifts from Table 11 to Table 12. The eleven hour span from L$_1$ to R$_3$ has actually lengthened by two positions in Table 12. It is possible that the first hour of Table 11 was overly long, and beginning the night with K$_2$ at −3 suggests that, or it is possible that the new star ending the night in Table 12 resulted in a rather short hour.

Besides the complete change of stars prior to O$_1$ it should be noted that Q$_5$ seems to alternate with R$_1$ which means, since they later appear in successive hours, that they are stars rather close together, at least from the viewpoint of transit times.

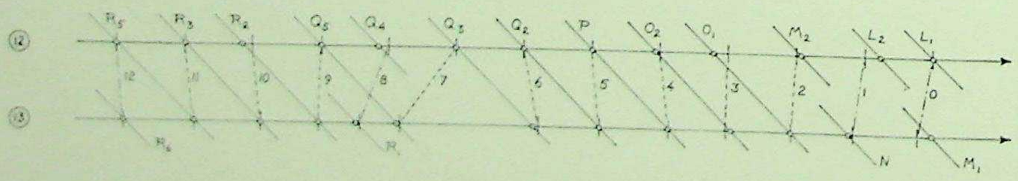
TABLE 13

(Plates 19, 49–50)

III *prt* 1

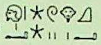
(0)	[*tpy*]-ꜥ *sbꜣ*[*wy*]	[*ḳꜥḥ iꜣby*]
(1)	*sbꜣ*[*w nw mw*]	[*irt wnmy*]
(2)	[*tp n mꜣi*]	[*ꜥḳꜣ ib*]
(3)	*s*[*d.f*]	[*irt iꜣby*]
(4)	*sbꜣw ꜥšꜣw*	[*ꜥḳꜣ ib*]
(5)	⟨*ṯꜣ nfr*⟩	[*ꜥḳꜣ ib*]
(6)	⟨*šmsw n ḥꜣt n mnit*⟩	*irt* [*wnmy*]
(7)	*šmsw n mnit*	*irt wnmy*
(8)	*rd n rrt*	*irt wnmy*
(9)	*pd.s*	*ꜥḳꜣ ib*
(10)	*ḥry-ib n mnty.s*	*ꜥḳꜣ ib*
(11)	*ḫpd.s*	*ꜥḳꜣ ib*
(12)	*mndt.s*	*ꜥḳꜣ ib*

	Table 12	Table 13
(0)	L_1 0	M_1 +3
(1)	L_2 +3	N −1
(2)	M_2 +1	O_1 0
(3)	O_1 −3	O_2 +1
(4)	O_2 −1	P 0
(5)	P 0	Q_2 0
(6)	Q_2 0	Q_3 −1
(7)	Q_3 0	Q_5 −1
(8)	Q_4 −2	R_1 −1
(9)	Q_5 0	R_2 0
(10)	R_2 −2	R_3 0
(11)	R_3 0	R_5 0
(12)	R_5 0	R_6 0


⑫
⑬
R5
R3
R2
Q5
Q4
Q3
Q2
P
O2
O1
M2
L2
L1
12
11
10
9
8
7
6
5
4
3
2
1
0
R6
R
N
M1

NOTES

The text of **A** is entirely gone and it is doubtful if the star chart belongs here as only 1 and 2 of the preserved stars agree with **C**, which appears to be correct throughout. However, the pattern fits no other chart.—**B** has completely disappeared. —**C** has the chart only.—The chart of **D** is for Table 24, though the text is correct.

0. The traces of **D** fit a restoration such as  and the star of **C** gives *k̦ʿḥ iꜣby*.

1. There are only two possibilities here, *sbꜣwy* or *sbꜣw nw mw* followed by *ḥr irt wnmy*. The traces are indecisive but the length of the entry makes the second the more plausible choice. Moreover in the only two tables where M_1 and M_2 have been together (Tables 7 and 10) the former has been at −3 and 0 while the latter has been at +1 and −2. It seems unlikely that M_1 would ever be at +3 and followed by M_2 at −1.

2. There is no other restoration possible.

3. The restoration is certain from the traces of .—From 6 on, the text has the locations preserved and the chart of **C** agrees perfectly. It is to be assumed that **C** has its stars also correctly placed for the earlier hours. For this reason we accept it in preference to the stars of **A** in 3 to 6 which consistently differ from **C**.

5. The text of **D** has *šmsw* preserved and that indicates *šmsw n ḥꜣt n mnit* but an emendation is essential since this star is found at 5 in Table 14 and it could never skip an hour (with no shift of the hour boundary to the right, be it noted) and then drop back again in the next table. Since *ṯꜣ nfr* is the star of 6 in Table 12 and 4 in Table 14 it is reasonable to emend it here.—Again, we take the star of **C** in preference to **A**.

6. Here again emendation is required as *mnit* is the star of 6 in Table 14 and as the star of 8 in Table 12 it would not skip to 6, with the hour boundary moving to the left and then remain at 6 in the next table. Q_3 is the only emendation possible. —The text of **D** has *irt* and the star of **C** is at *irt wnmy*, which we accept as opposed to the star of **A**.

8. The sign after is more likely for or than another .

9. **D**, is a phonetic determinative from *pḏt*, "bow", which may explain as well the presence of , though that is frequently found in combination with as in 10 and 11 following.

COMMENTARY

In 1500 B.C. III *prt* 1 was February 16 greg. Some indication of the shortening night may be detected in Table 13 as compared with Table 12. L_2 does not begin the night and the shift to M_1, especially at +3, suggests a later beginning, since M_1 must be an appreciable time interval after L_2, as in Tables 4 to 7 they mark successive hours.

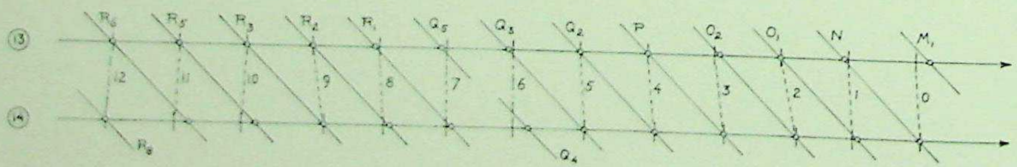
The six-hour span from P at 0 to R_3 at 0 remains the same in both tables but there is considerable shifting of hour boundaries with Q_4 dropping out and R_1 being introduced. It is clear that Q_3–Q_4–Q_5 must be two rather short hours while Q_5–R_2 must be a long one as the two combine into one with no shifting to closer positions and the single hour splits into two with only three positions added to its length. Noteworthy also are the shifts of O_1 from −3 to 0 and of O_2 from −1 to +1.

Table 14

(Plates 20, 50–51)

	III *prt* 16	
(0)	*sbꜣ⟨w⟩ nw mw*	*ʿḳꜣ ib*
(1)	*⟨tp n⟩ mꜣt*	*irt iꜣby*
(2)	*sd.f*	*ʿḳꜣ ib*
(3)	*sbꜣw ʿšꜣw*	*ʿḳꜣ ib*
(4)	*ṯꜣ nfr*	*ʿḳꜣ ib*
(5)	*šmsw ḥꜣt n mnit*	⸢*ʿḳꜣ ib*⸣
(6)	*mnit*	*ḳʿḥ iꜣby*
(7)	*rdwy n rrt*	⸢*irt*⸣ *iꜣby*
(8)	*pd.s*	*irt iꜣby*
(9)	*ḥry-ib mnty.s*	*ʿḳꜣ ib*
(10)	*ḫpd.s*	*ḳʿḥ iꜣby*
(11)	*⟨mndt⟩.s*	*ḳʿḥ iꜣby*
(12)	*šwty.s*	*ʿḳꜣ ib*

	Table 13	Table 14
(0)	M_1 +3	N 0
(1)	N −1	O_1 +1
(2)	O_1 0	O_2 0
(3)	O_2 +1	P 0
(4)	P 0	Q_2 0
(5)	Q_2 0	Q_3 0
(6)	Q_3 −1	Q_4 +3
(7)	Q_5 −1	R_1 +1
(8)	R_1 −1	R_2 +1
(9)	R_2 0	R_3 0
(10)	R_3 0	R_5 +3
(11)	R_5 0	R_6 +3
(12)	R_6 0	R_8 0



⑬
⑭
R_6
R_5
R_3
R_2
R_1
Q_5
Q_3
Q_2
P
O_2
O_1
N
M_1
12
11
10
9
8
7
6
5
4
3
2
1
0
R_8
Q_4

NOTES

B has entirely disappeared.

0. **A** omits ∩, *tp grḥ*, the name of the star and its location in the text. The star in the chart is to be shifted one position to the right to agree with the text and star of **C**.—**C** has the date confused, omits plural strokes with *sbꜣ* and has for .

1. **A** is corrupt and should be emended to *tp n mꜣi ḥr irt*.—**C** has for and omits —. On the determinative of *mꜣi* see the note to Table 5, 12.

5. Neither text agrees with the stars which are both at *ḳʿḥ iꜣby*. Since **C** seems, in this table, to be a more correct text than **A** we tentatively accept its location at *ʿḳꜣ ib* as a shift from −1 to +3 seems excessive.

6. **A**, *ʿḳꜣ ib* may conceivably belong to 5 where it would agree with **C**; emend *ḳʿḥ*.

7. Both stars are at *ḳʿḥ iꜣby* in the chart but since R_1 is at −1 in Table 13 a shift to +3 is too much and we prefer to accept the text of **C** with *irt iꜣby*.—**A** omits *ḥr irt*.—**C**, the ⌓ with may indicate a pronunciation **ⲣⲁⲧ** as in Coptic. On the determinative of *rrt* see the note to Table 10, 12.

9. There is the usual confusion with *mnit* in both texts. The star of **A** should be shifted one position to the left to agree with **C** and the texts.

11. An emendation is clearly required in **C** because *ns.s* is the star of 11 in Table 15 and 10 in Table 16; the original may have been and the error may possibly be through the hieratic, helped by memory.

COMMENTARY

In 1500 B.C. III *prt* 16 was March 3 greg. There is no direct evidence in the table that the night is shortening. The eleven-hour span from N to R_6 actually lengthens by two positions, but again it is probable that the hour dropped at the beginning of the night was some minutes longer than the one added at the end, since in some tables M_2 intervenes between M_1 and N. The same is not true of R_6 and R_8, as R_7 is never found between them.

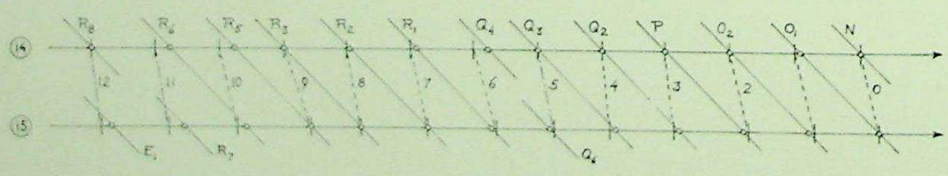
The other shifts in the table are the usual minor ones, though the change from Q_5 at −1 to Q_4 at +3 is noteworthy.

TABLE 15

(Plates 20, 51–52)

	IIII *prt* 1	
(0)	*tp n mꜣi*	*ꜥḳꜣ ib*
(1)	*sd.f*	*irt wnmy*
(2)	*sbꜣ⟨w⟩ ꜥšꜣw*	*irt wnmy*
(3)	*ṯꜣ nfr*	*irt iꜣby*
(4)	*šmsw ḥꜣt mnit*	*irt iꜣby*
(5)	*šmsw iy ⟨ḥr⟩-sꜣ mnit*	*irt ⟨wnmy⟩*
(6)	*rdwy n rrt*	*irt wnmy*
(7)	*pd.s*	*ꜥḳꜣ ib*
(8)	*ḥry-ib mnty.s*	*ꜥḳꜣ ib*
(9)	*ẖpd.s*	*ꜥḳꜣ ib*
(10)	*mndt.s*	*msḏr iꜣby*
(11)	*ns.s*	*ḳꜥḥ iꜣby*
(12)	*⟨tpy-ꜥ⟩ šwty nt nḫt*	*msḏr iꜣby*

	Table 14	Table 15
(0)	N 0	O_1 0
(1)	O_1 +1	O_2 −1
(2)	O_2 0	P −1
(3)	P 0	Q_2 +1
(4)	Q_2 0	Q_3 +1
(5)	Q_3 0	Q_6 −1
(6)	Q_4 +3	R_1 −1
(7)	R_1 +1	R_2 0
(8)	R_2 +1	R_3 0
(9)	R_3 0	R_5 0
(10)	R_5 +3	R_6 +2
(11)	R_6 +3	R_7 +3
(12)	R_8 0	E_1 +2



R8
R6
R5
R3
R2
R1
Q4
Q3
Q2
P
O2
O1
N
14
12
11
10
9
8
7
6
5
4
3
2
0
15
E1
R7
Q6

NOTES

A frequently omits *r* and *ḥr* before locations in this table.—**B** has entirely disappeared.—The text, but not the stars, of hours 1 to 4 of **C** of this table are repeated in error in Table 16. They are given here as C_2.

0. On the determinative of *mꜣt* see the note to Table 5, 12.—**C** omits *tp*.

1. **A**, the sign under 𓂋 is probably for 𓏏 as Twentieth Dynasty hieratic writes (*Wb.* IV, p. 363).

2. All texts omit the plural strokes.—**A**, emend *iꜣby* to *wnmy* to agree with the stars and C_1, C_2.

4. **A**, emend *wnmy* to *iꜣby* to agree with the stars and C_1, C_2.

5. Since in this table, at least, there are more errors in the texts than in the chart, it seems preferable to accept the star positions and emend **A** and **C** to *wnmy*.—**A**, probably emend *ḥr-sꜣ*, after the pattern of *ty ḥr-sꜣ sbꜣ n spdt*, since **C** has *sꜣ*.—**C**, probably emend *ḥr* before *sꜣ*.

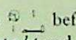
6. **C**, on the determinative of *rrt* see the note to Table 10, 12. It is just possible that there was hieratic confusion between 𓁹 and 𓂋. Emend *ḳꜥḥ* to *irt* to agree with the stars and **A**.

7. **C**, emend of course to .

8. The odd determinative is through confusion with *mnit* as in 4 above.—**C** omits *s*.

10. **A**, the misshapen sign under 𓂋 may be 𓏏, ▽ or though most probably 𓏏.—The star of **C** must be moved one position to the right to agree with **A** and the text.

11. **A** omits *s* and the star must be moved to the right side, to agree with **C** and the text.

12. Both charts omit the stars and **C** has no text after the hour.—**A** is surely to be emended with  before *šwty*, as *šwty nt nḫt* correctly appears in Table 16, 12 in **C** and in Table 16, 11 both **A** and **C** have *tpy-ꜥ šwty nt nḫt* and at *msḏr iꜣby* as well.

COMMENTARY

In 1500 B.C. IIII *prt* 1 was March 18 greg., near the vernal equinox. It is likely that the shortening night has been taken into account in 11 and 12. The span of ten hours from O_1 to R_6 has remained essentially the same in length. On the longest night of the year (Table 9) one hour was measured by N at -2 to O_1 at -1. This is comparable to the hour dropped by Table 15, N at 0 to O_1 at $+1$, and we have a right to assume that it is longer than the new hour added at the end of the table. Moreover, the change from R_8 at 0 to R_7 at $+3$ must mean a shortening of that hour but perhaps only by a rather small amount.

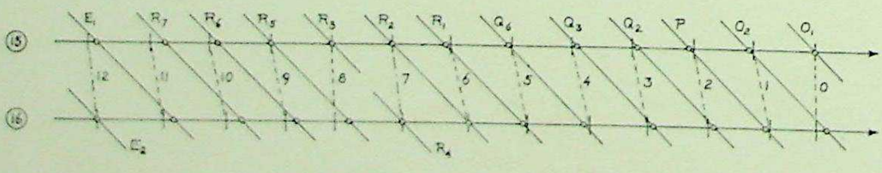
The other shifts in the table are the usual small adjustments in hour boundaries, except that the replacement of Q_4 at $+3$ by Q_6 at -1 is to be compared with the change in Table 14 of Q_5 at -1 to Q_4 at $+3$. As remarked on p. 7, Q_5 and Q_6 are alternates and are never found in successive hours.

TABLE 16

(Plates 21, 53–54)

	IIII *prt* 16	
(0)	*⟨sd n⟩ mꜣi*	*⟨msḏr⟩ iꜣby*
(1)	*sbꜣw ꜥšꜣ⟨w⟩*	*irt wnmy*
(2)	*ṯꜣ nfr*	*irt iꜣby*
(3)	*šmsw ḥꜣt mnit*	*irt iꜣby*
(4)	*šmsw iy ⟨ḥr-sꜣ⟩ mnit*	*irt wnmy*
(5)	*rdwy n rrt*	*irt wnmy*
(6)	*pd.s*	*ꜥḳꜣ ib*
(7)	*bꜣḥ.s*	*ꜥḳꜣ ib*
(8)	*ḫpd.s*	*ḳꜥḥ iꜣby*
(9)	*mndt.s*	*msḏr iꜣby*
(10)	*ns.s*	*ḳꜥḥ iꜣby*
(11)	*tpy-ꜥ šwty nt nḫt*	*msḏr iꜣby*
(12)	*šwty nt nḫt*	*ꜥḳꜣ ib*

	Table 15	Table 16
(0)	O_1 0	O_2 +2
(1)	O_2 −1	P −1
(2)	P −1	Q_2 +1
(3)	Q_2 +1	Q_3 +1
(4)	Q_3 +1	Q_6 −1
(5)	Q_6 −1	R_1 −1
(6)	R_1 −1	R_2 0
(7)	R_2 0	R_4 0
(8)	R_3 0	R_5 +3
(9)	R_5 0	R_6 +2
(10)	R_6 +2	R_7 +3
(11)	R_7 +3	E_1 +2
(12)	E_1 +2	E_2 0


E1
R7
R6
R5
R3
R2
R1
Q6
Q3
Q2
P
O2
O1
15
16
12
11
10
9
8
7
6
5
4
3
2
1
0
E2
R4

NOTES

A consistently omits *ḥr* and *r* before locations in this table.—A very little of **B** is preserved.—While the stars of **C** all belong to the chart for this table, hours 1 to 4 of the text are a duplicate of Table 15 and are to be found there.

0. **A**, the scribe has ignored ∩ in each case and the numbers 16 and 15 have been written with strokes. We must emend *mni* to *mꜣi* and *sd n* has been omitted, as also *ḥr msḏr*.—**C**, 𓏤𓏏 is an error, perhaps for 𓏏 after the numeral; *tp*, which may be here through the same copyist error as in 1 to 4, must be emended to *sd n*; *msḏr* has been omitted if the stars are to be trusted.

1. **A**, 𓇳𓏤 may be an error for the third plural stroke or a careless recollection of *sbꜣw nw mw*; *ʿšꜣ* is badly made and lacks plural strokes.—The star of **C** must be shifted one position to the right to agree with **A**.

4. Probably **A** has omitted 𓋹𓏤 𓏊𓏤.

5. **C**, on the determinative of *rrt* see the notes to Tables 15, 6 and 10, 12.

6. **C** has *pdwy*, a dual which occurs in no other table.

9. **A**, emend *ḳʿḥ* to *msḏr* to agree with the stars and **C**. The star at *ḳʿḥ* was no doubt added to agree with the text as a correction.—**C** omits 𓂋 of *mndt*.

10. **A** omits *s*.

11. **A** omits *msḏr*.

12. **A** has *tp ḥḏ nt nḫt* which is a miscopy from Table 17, 12. The *iꜣby* which follows, with no location given, would appear to be a copy of 11 which also has *nḫt iꜣby* as though there were a pair of giants, one right and one left.—**C** and the stars have every appearance of being correct.

COMMENTARY

In 1500 B.C. IIII *prt* 16 was April 2 greg. The night continues to shorten and the table appears to document this fact. O_2, beginning the night, has shifted from −1 to +2, a delay of three positions, while E_1 at +2 in Table 15 has remained there in Table 16. The hour which drops, O_1 to O_2, has been one of the most consistent and in Table 9, for the longest night, it was but two positions longer than in Table 15. It is to be presumed that the new hour, E_1 to E_2, does not equal the dropped one in time.

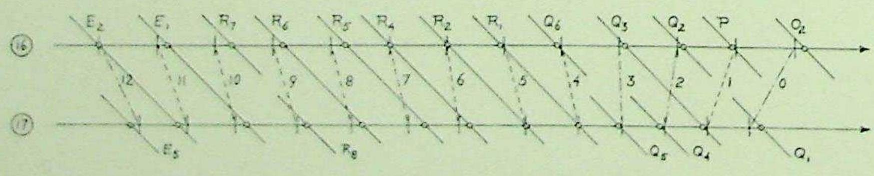
No less than nine stars retain the positions they had in Table 15. This is an unusually high percentage. Besides the shift of O_2, R_3 at 0 has changed to R_4 at 0 which no doubt accounts for the shift of R_5 from 0 to +3.

TABLE 17

(Plates 21, 54–55)

	I *šmw* 1	
(0)	*⟨⸢tpy-⸣⟩ mnit*	*msḏr i͗ꜣby*
(1)	*šmsw ⟨n⟩ ḥꜣt n mnit*	*irt wnmy*
(2)	*mnit*	*irt wnmy*
(3)	*šmsw ⟨n⟩ mnit*	*irt wnmy*
(4)	*rdwy n rrt*	*ʿḳꜣ ib*
(5)	*pd.s*	*ʿḳꜣ ib*
(6)	*bꜣḥ.s*	*msḏr i͗ꜣby*
(7)	*ḫpd.s*	*kʿḥ i͗ꜣby*
(8)	*mndt.s*	*msḏr i͗ꜣby*
(9)	*šwty.s*	*msḏr i͗ꜣby*
(10)	*tpy-ʿ šwty nt nḫt*	*⟨msḏr⟩ i͗ꜣby*
(11)	*šwty nt nḫt*	*msḏr wnmy*
(12)	*tp ḥḏ nt nḫt*	*msḏr wnmy*

	Table 16	Table 17
(0)	O_2 +2	Q_1 +2
(1)	P −1	Q_3 −1
(2)	Q_2 +1	Q_4 −1
(3)	Q_3 +1	Q_5 −1
(4)	Q_6 −1	R_1 0
(5)	R_1 −1	R_2 0
(6)	R_2 0	R_4 +2
(7)	R_4 0	R_5 +3
(8)	R_5 +3	R_6 +2
(9)	R_6 +2	R_8 +2
(10)	R_7 +3	E_1 +2
(11)	E_1 +2	E_2 −2
(12)	E_2 0	E_5 −2


E2
E1
R7
R6
R5
R4
R2
R1
Q6
Q3
Q2
P
O2
⑯
12
11
10
9
8
7
6
5
4
3
2
1
0
⑰
E5
R8
Q5
Q4
Q1

NOTES

B has very little preserved of the text and nothing of the chart.

0. All texts have *msḏr*, **A** and **C** have *iꜣby* as well and the star of **A** agrees. Apparently then the hour boundary at +2 is assured. All texts also have *mnit* which cannot be correct by itself. There are two possibilities; (a) the texts should be emended to *sbꜣw ꜥšꜣw*, and (b) *mnit* is correct but something has dropped out before it, such as *tpy-ꜥ* or *ḥꜣt*. If we emend to *sbꜣw ꜥšꜣw* the shift from −1 to +2 could be accepted as the necessary delay in beginning the night since it is shortening. If we restore *tpy-ꜥ* before *mnit* we have a star which must be considered an alternate to *sbꜣw ꜥšꜣw* and the location at +2 would also fit well with a later beginning of the night. We have tentatively decided to adopt the second possibility as the emendation doing least violence to the text. Of course, *ḥꜣt*, based on the following star, *šmsw n ḥꜣt n mnit*, is just as attractive a restoration as *tpy-ꜥ* and may indeed be the correct one.—**A**, the signs after *msḏr* are inexplicable.—**C**, the star must be shifted one space to the left.

1. **A** and **C** have *irt wnmy* and it seems preferable to accept the text and not the location of the stars at *irt iꜣby* since the star skips an hour and the hour boundary ought to shift to the left.—**C**, ııı is probably an error for —. **C** omits *ḥr* as probably does **B**.

2. The broken area in the chart of **C** is the only place where a star could have been drawn.

3. From 3 on **A** consistently omits *ḥr*.—**C**, ııı is for — as in 1.

4. **A**, the sign under ⌓ may be either ⸜ or ◊, though probably the latter; *r* is omitted.—**C**, on the ⌓ see the note to Table 14, 7. We should expect *n rrt* as is customary at the first mention of a constellation, rather than *s*.

6. **A**, —☥ is omitted.—**C**, the star must be shifted one position to the left to agree with the text and **A**.

7. **C** omits *ḥr*.

10. Both **A** and **C** omit *msḏr*, the location of the stars.

11. **A**, emend *iꜣby* to *wnmy* to agree with **C**. The star of **A** was placed off to the side, as though the scribe was uncertain where to put it.

12. As in 11, *q.v.*, the star of **A** has been placed off to the side.

COMMENTARY

In 1500 B.C. I *šmw* 1 was April 17 greg. The shortening of the night is evidenced to some extent by the shifts at the beginning and end of Table 17. P at +1 gives way to Q_1 at +2 as the star of beginning the night. The discussion above under 0 explains the probable delay and the diagram illustrates the fact that the two hours from Q_3 to R_1 of Table 16 have now become three, with an increase of only three positions between the two stars.

At the other end of the night E_2 has moved from 0 to −2 with a consequent shortening of the 11th hour and the new star (E_5) at −2 is hardly likely to result in a 12th hour of any excessive length.

Curious is the exchange of R_8 with R_7 since R_6, before, and E_1, after, both maintain the same positions at +2. In Table 16 we must have a short hour (R_6-R_7) followed by a rather longer one (R_7-E_1) while Table 17 reverses this.

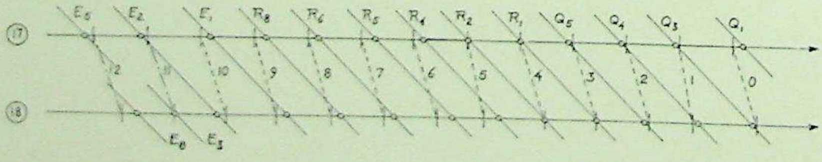
TABLE 18

(Plates 22, 56–57)

I *šmw* 16

(0)	*šmsw* ⟨*n ḫꜣt n mnit*⟩	*irt wnmy*
(1)	*mnit*	*irt iꜣby*
(2)	*šmsw* ⟨*n*⟩ *mnit*	*irt wnmy*
(3)	*rdwy n rrt*	*ꜥḳꜣ ib*
(4)	*pd.s*	*ꜥḳꜣ ib*
(5)	*bꜣḥ.s*	*ḳꜥḥ iꜣby*
(6)	*ḫpd.s*	*ḳꜥḥ iꜣby*
(7)	*mndt.s*	*msḏr* ⟨*iꜣby*⟩
(8)	*šwty.s*	*msḏr iꜣby*
(9)	*tpy-ꜥ šwty nt nḫt*	*msḏr iꜣby*
(10)	*šwty nt nḫt*	*msḏr wnmy*
(11)	*tpy-ꜥ ḥḏ.f*	*ꜥḳꜣ ib*
(12)	*ḫꜣb.f*	*ḳꜥḥ iꜣby*

	Table 17	Table 18
(0)	Q_1 +2	Q_3 −1
(1)	Q_3 −1	Q_4 +1
(2)	Q_4 −1	Q_5 −1
(3)	Q_5 −1	R_1 0
(4)	R_1 0	R_2 0
(5)	R_2 0	R_4 +3
(6)	R_4 +2	R_5 +3
(7)	R_5 +3	R_6 +2
(8)	R_6 +2	R_8 +2
(9)	R_8 +2	E_1 +2
(10)	E_1 +2	E_2 −2
(11)	E_2 −2	E_3 0
(12)	E_5 −2	E_8 +3


E5
E2
E1
R8
R6
R5
R4
R2
R1
Q5
Q4
Q3
Q1
17
18
12
11
10
9
8
7
6
5
4
3
2
1
0
E8
E3

NOTES

A consistently omits *ḥr* and *r* before locations.—**B** has little preserved.

0. **A**, the extra three strokes in the date are inexplicable; *n ḥꜣt n mnit* has dropped after *šmsw*.—**C** omits 16 in the date and *kꜥḥ* is no doubt to be emended to *irt* to agree with **A** and its star.

1. **C** has an intrusive 𓇳 before *mnit* which cannot be accounted for. The same sign appears in **C** in Table 19, 1 and 2.

2. **C**, emend ı ı ı to — and *iꜣby* to *wnmy* to agree with the star and **A**, **B**.

3. **A** omits 𓏏 after *rr*.

5. **A**, | after *kꜥḥ* is meaningless and must be an error.—**C**, the text may have had only —, as in Table 10, 9, 11 and 12 of **A**, which the scribe then unthinkingly rendered as *rmn* instead of *kꜥḥ*.

6. **A** omits *iꜣby*.—**C** omits *s*.

7. **A** omits *s* and either *iꜣby* or *wnmy*.—Despite the apparent unanimity of star and **C**, it seems well-nigh certain that *iꜣby* must be restored in **A** and emended elsewhere, because of the jump in Table 19 to the 5th hour at −1 and the introduction of *ns.s* in 6. Some slight support for this may be found in the omission in **A** and the fact that the stars of **A** and **C** are wrong in any event and may have been placed where they are without reason, with *wnmy* later added to **C** because of their position.

8. **C**, the star must be shifted one space to the left.

9. Stars (except for **C** at *kꜥḥ wnmy*) and texts agree on *msḏr wnmy*. Nevertheless we believe that an emendation to *msḏr iꜣby* is required by the pattern of the hour boundaries of the stars surrounding E_1, in Tables 17, 18 and 19. R_8 is at +2 in all three and E_2 is at −2, −2 and 0. That E_1 should go from +2 to −2 and then back again is possible, but unlikely. Moreover, the pattern of the stars in 10, with **C** off one position to the left, suggests that 9 was copied from it in error, both in chart and texts.—**A** omits ▭.

10. **C**, the star must be shifted one position to the right.

11. **A**, the star must be shifted one position to the right.—**C**, the sign over — looks like ◦ but may be a badly written ⌓ or ○. If the latter, it would be, as in **A**, a determinative borrowed from *ḥd*, "to be bright".

12. Despite the position of the stars and the text of **C**, it seems preferable to accept the text of **A** as correct, since this star skips to 10 in Table 19 and there it is at 0.—**C**, ⌋ has been omitted.

COMMENTARY

In 1500 B.C. I *šmw* 16 was May 2 greg. It is not possible to detect any shortening of the night from Table 17 to Table 18. We can only assume that the hour dropped (Q_1–Q_3) was longer than the hour added (E_3–E_8). This last seems like a long hour but we must remember that E_3 to E_6 are all alternates as are also E_7 and E_8.

With the emendations proposed in the notes the positional changes between the tables are not striking. Q_4 shifts from −1 to +1, R_4 from +2 to +3, and E_5 at −2 gives way to E_3 at 0.

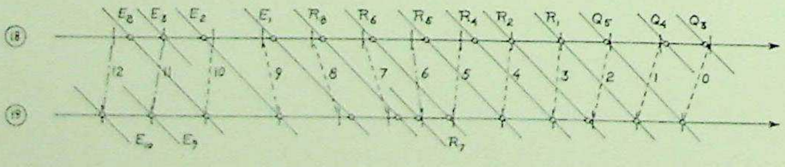
TABLE 19

(Plates 23, 57–59)

II *šmw* 1

(0)	*⟨šmsw⟩ n mnit*	*ʿḳꜣ ib*
(1)	*rdwy n rrt*	*ʿḳꜣ ib*
(2)	*pd.s*	*irt wnmy*
(3)	*bꜣḥ.s*	*ʿḳꜣ ib*
(4)	*ḫpd.s*	*ʿḳꜣ ib*
(5)	*mndt.s*	*irt wnmy*
(6)	*ns.s*	*irt wnmy*
(7)	*šwty.s*	*msḏr i͗ꜣby*
(8)	*tpy-ʿ šwty nt nḫt*	*msḏr i͗ꜣby*
(9)	*šwty nt nḫt*	*ʿḳꜣ ib*
(10)	*ẖꜣb.f*	*ʿḳꜣ ib*
(11)	*mndt.f*	*ʿḳꜣ ib*
(12)	*bgs.⟨f⟩*	*ʿḳꜣ ib*

	Table 18	Table 19
(0)	Q_3 -1	Q_5 0
(1)	Q_4 $+1$	R_1 0
(2)	Q_5 -1	R_2 -1
(3)	R_1 0	R_4 0
(4)	R_2 0	R_5 0
(5)	R_4 $+3$	R_6 -1
(6)	R_5 $+3$	R_7 -1
(7)	R_6 $+2$	R_8 $+2$
(8)	R_8 $+2$	E_1 $+2$
(9)	E_1 $+2$	E_2 0
(10)	E_2 -2	E_8 0
(11)	E_3 0	E_9 0
(12)	E_8 $+3$	E_{10} 0


(18)
(19)
E8
E3
E2
E1
R8
R6
R5
R4
R2
R1
Q5
Q4
Q3
12
11
10
9
8
7
6
5
4
3
2
1
0
E10
E9
R7

NOTES

A consistently omits *r* and *ḥr* before locations.—**B** is much destroyed.—**C** has text only as the star chart belongs to Table 20. —The chart which follows the text of **D** belongs to some other table, not identifiable. The correct chart for Table 19 follows Table 20, but only the stars from 1 to 6 are usable in determining locations. As usual 0 and 1 are on one line of text but the stars are not doubled up.

0. There are two almost equally attractive alternatives in interpreting the texts and one star for the beginning of the night. The first is *mnit* at *ḳꜥḥ iꜣby*. **A** has *mnit*, the star of **A** is correct for *ḳꜥḥ iꜣby* and the one sign preserved in **B** is ♀ which rules out *ꜥḳꜣ ib*, as that takes 𓂋. Moreover a shift of the hour boundary from +1 to +3 would be desirable as indicating a delay in beginning the night, which continues to shorten, and as a shift in the proper direction to compensate for the dropping out of Q_5. The second alternative is to emend to *šmsw n mnit* at *ꜥḳꜣ ib*. **A** has *ꜥḳꜣ ib*, the traces in **C** after *grḥ* can fit ‡| (though the date is for Table 20 and perhaps the whole text is wrong) and **D** has — before *mnit*. The jump of Q_5 from the 2nd hour to beginning the night would fit well with a shortening night. It is this fact which inclines us to favor the second alternative. —**D** has no star in the chart.

1. **C**, on the second *tpy* see the note to Table 18, 1; (*n*) *rrt* has been omitted.

2. **C**, emend to *pd.s*; on *tp* see the preceding note.—**D**, emend *iꜣby* to *wnmy* to agree with the stars and **A**, **C**.

3. **A**, the sign for *bꜣḥ* is probably a confusion of 𓅡 and ⌒ in the hieratic.—**D**, emend ↼ to —.

4. **D**, the scribe must have misinterpreted a bad or worn writing of *ḫpd.s* as *psdt*, "back".

5. **B**, the traces indicate *iꜣby*, as in **D**, but since **A** and **C** have *wnmy*, with the stars of **A** and **D** so, it seems best to emend **B** and **D** to *wnmy*, especially since a skipped hour is involved and a shift to the left of three positions is highly desirable.

6. **D** omits *s*. The intrusion of *nt* between *irt* and *wnmy*, thus taking the latter as a noun, is found only here.

7. The stars of **A** and **B** should be shifted one position to the left to agree with the texts.—**B** and **C** have 𓋴 before the suffix *sy* which suggests that the scribe has misinterpreted 𓋴𓋴 as *gswy*.—**D** has ◟ for 𓏏 and omits *s*. From here on the stars of **D** are useless as evidence and are placed in the main over the head of the figure, since they cannot be placed on it.

8. Despite **D** and the location of the stars of **A** and **B** it seems preferable to accept the texts of **A**, **B** and **C** which have *iꜣby* with *msḏr*. This was the location of E_1 in Table 18 and a shift to the left of four positions for no apparent reason would be difficult to accept.

10. Here and in Table 20, 9 **A** has *ḫꜣb*, the current rendering of the older *ḥꜣb*.—**D**, emend — to ↼.

11. **A**, emend 𓋴 to ↼; the confusion is with 5 above.—**C**, there is no explanation for the presence of *tp mnit*, instead of *mndt*, other than scribal carelessness.

12. **A**, *ꜣgb.s* is a scrambling of *bgs* which then in **A** in later tables is corrected to *ꜣgb.f*.—**C** omits ↼.—**D**, emend — to ↼ as in 10 above.

COMMENTARY

In 1500 B.C. II *šmw* 1 was May 17 greg. There can be little doubt that Table 19 evidences a delay in beginning the night, discussed above under 0. Moreover R_1 skips an hour but remains at 0. The diagram shows this and other changes.

The shortening of interior hours is shown by the increase from five to six of the hours between R_1 and R_8.

The end of the night also changes. E_3 drops out between E_2 and E_8 with compensatory shifts of hour boundaries. The two new hours ending with E_9 and E_{10} are probably short ones but this cannot be demonstrated.

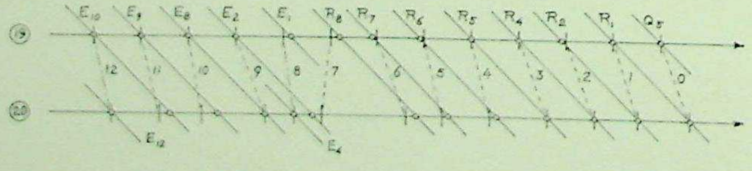
TABLE 20

(Plates 24, 59–61)

II *šmw* 16

(0)	*rdwy n rrt*	*ꜥḳꜣ ib*
(1)	*pd.s*	*ꜥḳꜣ ib*
(2)	*bꜣḥ.s*	*ꜥḳꜣ ib*
(3)	*ḫpd.s*	*ꜥḳꜣ ib*
(4)	*mndt.s*	*irt iꜣby*
(5)	*ns.s*	*irt iꜣby*
(6)	*šwty.s*	*msḏr iꜣby*
(7)	*⟨šwty⟩ nt nḫt*	*msḏr wnmy*
(8)	*tp.f*	*ꜥḳꜣ ib*
(9)	*ḫꜣb.f*	*ꜥḳꜣ ib*
(10)	*mndt.f*	*ḳꜥḥ iꜣby*
(11)	*bgs.f*	*msḏr iꜣby*
(12)	*pd.f*	*ꜥḳꜣ ib*

	Table 19	Table 20
(0)	Q_5 0	R_1 0
(1)	R_1 0	R_2 0
(2)	R_2 −1	R_4 0
(3)	R_4 0	R_5 0
(4)	R_5 0	R_6 +1
(5)	R_6 −1	R_7 +1
(6)	R_7 −1	R_8 +2
(7)	R_8 +2	E_2 −2
(8)	E_1 +2	E_4 0
(9)	E_2 0	E_8 0
(10)	E_8 0	E_9 +3
(11)	E_9 0	E_{10} +2
(12)	E_{10} 0	E_{12} 0



⑲
⑳
E10
E9
E8
E2
E1
R8
R7
R6
R5
R4
R2
R1
Q5
12
11
10
9
8
7
6
5
4
3
2
1
0
E12
E4

NOTES

A consistently omits *r* and *ḥr* before locations.—**C** has two star charts flanking the text, one of which is now almost completely destroyed.—The chart for **D** is after Table 21. Again 0 and 1 are on one line but the stars are not doubled.

2. **A**, cf. the note to Table 19, 3.—**D**, 𓏏 is an error through the hieratic for 𓋴.

3. **D**, 𓏏𓋴 is perhaps brought along from Table 19, 4; see the note there.

4. **D** omits *s*. There is an extra star in this line of the chart and from here on it is useless.

6. **A** omits *s*.—The star of **C** must be shifted one position to the left.—**D**, emend 𓎛𓏭 to 𓏏𓏭; the scribe may have thought he was writing *gswy*.

7. **A**, **B** and **D** unite in omitting either *tpy-ʿ šwty* or *šwty*. The former seems out of the question as a restoration since in Table 21 it is at *ʿḳ3 ib* in the 5th hour and that would mean a skipped hour and a retrograde position. We prefer to emend to *šwty*.

8. **A**, emend 𓊃 to 𓆓.

10. **A** omits 𓆓.—**D**, emend 𓆄 to 𓆓 (confusion with 4 above); *ḥr* is omitted.

11. **A**, emend to *bgs* and see the note to Table 19, 12.—**C**, an original 𓌙 has been corrected to 𓆓.—**D** omits *ḥr*.

COMMENTARY

In 1500 B.C. II *šmw* 16 was June 1 greg. That the night continues to shorten and begins later than in Table 19 is probable on the basis of the diagrams of the beginnings of Tables 18 to 20.

Between R_8 and E_{10} there is considerable shuffling of alternates and shifting of positions. This can be interpreted as a crowding of short hours, but there is no conclusive evidence of this. We assume that the new hour is short to balance the delayed beginning of the night.

In connection with the gradual shortening of the night after Table 9 it is worth pointing out that the constellation of *rrt* when R_8 ended the 12th hour in Table 14, covered five hours from R_1 at $+1$ to R_8 at 0 and these five hours remained at that number through Tables 15, 16, 17 and 18. In Tables 19 and 20, however, R_1 at 0 to R_8 at $+2$ cover six hours, a clear indication that the hours on the average are shorter, since three added positions could hardly be counted an additional hour.

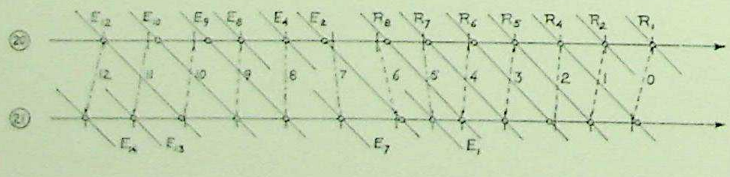
Table 21

(Plates 25, 61–63)

III *šmw* 1

(0)	*bꜣḥ n rrt*	*irt iꜣby*
(1)	*ẖpd.s*	*ꜥḳꜣ ib*
(2)	*mndt.s*	*irt wnmy*
(3)	*ns.s*	*ꜥḳꜣ ib*
(4)	*šwty.s*	*ꜥḳꜣ ib*
(5)	*tpy-ꜥ šwty nt nḫt*	*ꜥḳꜣ ib*
(6)	*šwty nt nḫt*	*irt iꜣby*
(7)	*nḫbt.f*	*ꜥḳꜣ ib*
(8)	*mndt.⟨f⟩*	*ꜥḳꜣ ib*
(9)	*⟨bgs⟩.f*	*ꜥḳꜣ ib*
(10)	*pd.f*	*irt* ⌜*wnmy*⌝
(11)	*sbk.f*	*ꜥḳꜣ ib*
(12)	*pt.f*	*ꜥḳꜣ ib*

	Table 20	Table 21
(0)	R_1 0	R_4 +1
(1)	R_2 0	R_5 0
(2)	R_4 0	R_6 −1
(3)	R_5 0	R_7 0
(4)	R_6 +1	R_8 0
(5)	R_7 +1	E_1 0
(6)	R_8 +2	E_2 +1
(7)	E_2 −2	E_7 0
(8)	E_4 0	E_9 0
(9)	E_8 0	E_{10} 0
(10)	E_9 +3	E_{12} −1
(11)	E_{10} +2	E_{13} 0
(12)	E_{12} 0	E_{14} 0


E_{12}
E_{10}
E_9
E_8
E_4
E_2
R_8
R_7
R_6
R_5
R_4
R_2
R_1
⑳
12
11
10
9
8
7
6
5
4
3
2
1
0
㉑
E_{14}
E_{13}
E_7
E_1

NOTES

A consistently omits *r* and *ḥr* before locations.—D has only 0 to 11 in twelve lines of text and omits 12. The star chart for Table 21 is after Table 22. It gives the stars for 1 to 12 and takes as the *ʿḳȝ ib* vertical the one which would normally be *msḏr wnmy*.

0. The stars of A, B and C are at *irt iȝby* and the texts of B and D give that location. A and C have *irt wnmy*. With the bulk of the evidence in its favor we prefer the former location even though the star skips an hour and this frequently means a shift of the hour boundary to the right. But Table 21, as we shall see, is for the shortest night of the year and it is not impossible that R_4 should skip to beginning the night, and even have a small additional delay of a position at +1. In any event, the difference in time between −1 and +1 cannot be very great and it is clear that there is a delay, over Table 20, with either.—A, see the note to Table 19, 3; the suffix *s* is of course unnecessary.—B, on the writing of *rrt* cf. Tables 10 12; 15, 6; 16, 5. B also has a superfluous suffix pronoun.—C, the determinative must be a badly made 𓊹.

1. B, 𓏏 may be for 𓇳 leaving only 𓂋 of *ḫpd* omitted.—D, emend ○ to 𓂋.

2. A omits 𓇋.—D must be emended to *irt wnmy* to agree with the star and A, B, C.

3. A omits 𓇋.

5. The star at *irt iȝby* of A must be an error corrected by putting in the proper star without erasure.—B, 𓈖 has been thoughtlessly copied from the preceding line.—C, on 𓈖 see under B; originally the text was probably 𓈖𓂋𓇳𓏏 with omission of 𓈖𓏏.

6. A, emend to *iȝby* to agree with stars and B, D.—D, 𓂋 could be a hieratic error for 𓈖.

8. A omits 𓂝.

9. A, emend to *bgs*, cf. note to Table 19, 12.

10. Despite the stars and *iȝby* of B it is preferable to accept *wnmy* of A as the correct location since the star skips an hour and was at *ʿḳȝ ib*.—A, 𓂝 seems to have been squeezed in later.

11. A, emend 𓇋 to 𓋴.

12. A, on ○ in *pt* see the note to C, Table 2, 4.—C, the head of the target intrudes into the chart and displaces the star.

COMMENTARY

In 1500 B.C. III *šmw* 1 was June 16 greg. Table 21 then should take in the shortest night of the year. It is immediately clear that the beginning of the night is later than in Table 20 since two hours preceded R_4 there and a shift to the left of one position contributes to a delay in beginning the night. While this in itself is sufficient to confirm the further shortening of the night it would be a satisfaction to have the end of the night also give confirmation. Unfortunately this is not the case and, since the 12th hour star of Table 20 (E_{12}) skips an hour, two new hours have to be added in Table 21. The diagram shows the shifts and changes which occur in the constellation of *nḫt*, which now exhibits its greatest number of hours, seven in all. They must all be quite short.

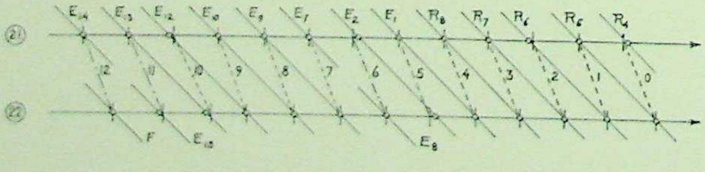
TABLE 22

(Plates 26, 63–65)

III *šmw* 16

(0)	*ḫ⟨pd⟩ n rrt*	*ꜥḳꜣ ib*
(1)	*mndt.s*	*ꜥḳꜣ ib*
(2)	*ns.s*	*ꜥḳꜣ ib*
(3)	*šwty.s*	*ꜥḳꜣ ib*
(4)	*tpy-ꜥ šwty nt nḫt*	*ꜥḳꜣ ib*
(5)	*šwty nt nḫt*	*irt iꜣby*
(6)	*ḫꜣb.f*	*ꜥḳꜣ ib*
(7)	*mndt.f*	*ꜥḳꜣ ib*
(8)	*bg⟨s⟩.f*	*ꜥḳꜣ ib*
(9)	*pd.f*	*ꜥḳꜣ ib*
(10)	*sbḳ.f*	*irt wnmy*
(11)	*iy sꜣ pt.f*	*irt wnmy*
(12)	*ꜥryt*	*ꜥḳꜣ ib*

	Table 21	Table 22
(0)	R_4 +1	R_5 0
(1)	R_5 0	R_6 0
(2)	R_6 −1	R_7 0
(3)	R_7 0	R_8 0
(4)	R_8 0	E_1 0
(5)	E_1 0	E_2 +1
(6)	E_2 +1	E_8 0
(7)	E_7 0	E_9 0
(8)	E_9 0	E_{10} 0
(9)	E_{10} 0	E_{12} 0
(10)	E_{12} −1	E_{13} −1
(11)	E_{13} 0	E_{15} −1
(12)	E_{14} 0	F 0


E14
E13
E12
E10
E9
E7
E2
E1
R8
R7
R6
R5
R4
21
12
11
10
9
8
7
6
5
4
3
2
1
0
22
F
E15
E8

NOTES

A consistently omits *r* and *ḥr* (except 10 and 11) before locations.—Much of **D** is missing. Presumably the star chart for this table followed Table 23 but if so nothing useful is preserved.

0. **A** has only *ḥp n* for *ḥpd n rrt ʿḳꜣ ib* through lack of room.—**C**, emend to .

1. **C**, the presence of is inexplicable.

3. **C**, emend to .

4. **A** omits .—**C**, has been omitted; emend to ; is a thoughtless repetition from the preceding hour; is to be emended to .

5. **C**, on and see the preceding notes; an original has been corrected to .

7. **A** omits .

8. **A**, emend to *bgs*, cf. note to Table 19, 12.—**C** omits *s* of *bgs*.

10. **C** copies *r ʿḳꜣ ib* from the preceding hour and then corrects it.

11. **A** omits *pt.f.*—**C**, emend to , an error through the hieratic.—**D**, is for as in Table 4, 10; is an easy hieratic error for ; emend to , possibly a misreading of the hieratic.

COMMENTARY

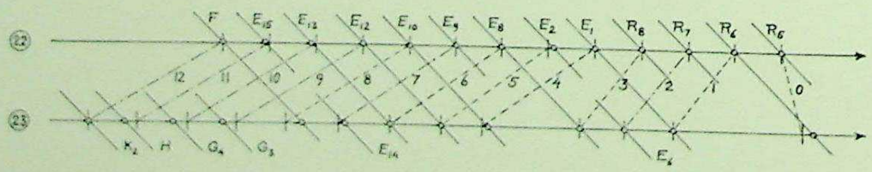
In 1500 B.C. III *šmw* 16 was July 1 greg. The night should begin to lengthen again, but so little that there can be no evidence of this in the transition from Table 21 to Table 22. There are two interchanges, E_8 for E_7 and E_{15} for E_{14} but no skipped hours and little positional change.

TABLE 23

(Plates 27, 65–66)

	IIII *šmw* 1	
(0)	*mndt n rrt*	*⟨msḏr iꜣb⟩y*
(1)	*tpy-ꜥ šwty nt ⟨nḫt⟩*	*ꜥḳꜣ ib*
(2)	*ḥḏ nt nḫt*	*ꜥḳꜣ ib*
(3)	*ḫꜣ⟨b⟩.f*	*ꜥḳꜣ ib*
(4)	*bgs.f*	*irt iꜣby*
(5)	*pd.f*	*ꜥḳꜣ ib*
(6)	*sbḳ.f*	*ꜥḳꜣ ib*
(7)	*pt.f*	*irt iꜣby*
(8)	*ꜥryt*	*ḳꜥḥ iꜣby*
(9)	*ḥtyt nt ꜣpd*	*ḳꜥḥ iꜣby*
(10)	*kft.f*	*ḳꜥḥ iꜣby*
(11)	*sbꜣ n ḫꜣw*	*ḳꜥḥ iꜣby*
(12)	*sbꜣ n sꜣḥ*	*ꜥḳꜣ ib*

	Table 22	Table 23
(0)	R_5 0	R_6 +2
(1)	R_6 0	E_1 0
(2)	R_7 0	E_6 0
(3)	R_8 0	E_8 0
(4)	E_1 0	E_{10} +1
(5)	E_2 +1	E_{12} 0
(6)	E_8 0	E_{13} 0
(7)	E_9 0	E_{14} +1
(8)	E_{10} 0	F +3
(9)	E_{12} 0	G_3 +3
(10)	E_{13} −1	G_4 +3
(11)	E_{15} −1	H +3
(12)	F 0	K_2 0



F
E_{15}
E_{13}
E_{12}
E_{10}
E_9
E_8
E_2
E_1
R_8
R_7
R_6
R_5
22
23
12
11
10
9
8
7
6
5
4
3
2
1
0
K_2
H
G_4
G_3
E_{14}
E_6

NOTES

A and **D** are only partially preserved.—**B** has disappeared completely.—The stars of **C** can sometimes be seen in the chart only as a black stroke on the verticals (red filter).—This table is very corrupt in its present state and requires extensive emendations which we shall offer after we present the table as it is.

0. The stars of **A** and **C** are at *msḏr iꜣby* and 𓄤 of **C** can easily be an error for 𓊽 through the hieratic; 𓈖 could then have been added to the original misreading.

1. **C** omits *šwty nt* and has *rrt* where we expect to find *nḫt*. At least one hour has been omitted in the text between *mndt.s* and *tpy-ʿ šwty nt nḫt*. The latter could hardly skip two hours and still remain at 0.

2. **C** adds an irrelevant *iꜣby* which might have dropped from 0 or might indicate that this should really be the 4th hour since that is at *irt iꜣby* and the text may well have omitted another hour.

3. **C** omits 𓃀.

7. **C** corrects *r ʿkꜣ ib* to *irt iꜣby*.—**D**, ⧈ is an error through the hieratic for □; a column line runs through the text after *pt*, and through the following texts as well.

9. **C**, the determinative 𓈗 is probably borrowed from *ḥyt*, "rain", unless it is to be emended to 𓅭 which is otherwise missing.—**D**, the traces suggest 𓅭 𓄡? but what could the 𓄡 represent?—The only "throat" possible here, if correct, would be that of *ꜣpd* and we prefer to take it as such, and as an alternate to *tp* and *bʿnt nt ꜣpd*.

10. **C** omits *ḥr*.

COMMENTARY

In 1500 B.C. IIII *šmw* 1 was July 16 greg. The night is lengthening but the obvious corruption of Table 23 prevents any attestation of this. One has only to look at the diagram and to recall that *sbꜣ n sꜣḥ* (K_2) was the 12th hour star in Table 1 to see the difficulties which confront an attempt to reconstitute Table 23. This must be done but our task requires that Table 24 be taken into account as well and it will be better to postpone all discussion until we have examined that text.

TABLE 24

(Plates 28, 67)

IIII *šmw* 16

(0)	*šwty n rrt*	⟨*msḏr iꜣby*⟩
(1)	*šwty [nt nḫt]*	*ʿḳꜣ ib*
(2)	. . . . .	[*ʿḳꜣ ib*]
(3)	*nḫ[bt.f]*	*irt iꜣby*
(4)	*mn[dt.f]*	*irt wnmy*
(5)	*bgs.[f]*	*msḏr wnmy*
(6)	*s[bk.f]*	*ḳʿḥ iꜣby*
(7)	⟨*pt*⟩*.f*	*irt iꜣby*
(8)	*ʿryt*	*ʿḳꜣ ib*
(9)	⟨*tp n*⟩ *ꜣpd*	⟨*msḏr*⟩ *iꜣby*
(10)	⟨*kft*⟩*.f*	*irt iꜣby*
(11)	*sbꜣ n ḫꜣw*	*irt wnmy*
(12)	*sbꜣ n [sʿr]*	*ʿḳꜣ ib*

	Table 23	Table 24
(0)	R_6 +2	R_8 +2
(1)	E_1 0	E_2 0
(2)	E_6 0	? 0
(3)	E_8 0	E_7 +1
(4)	E_{10} +1	E_9 −1
(5)	E_{12} 0	E_{10} −2
(6)	E_{13} 0	E_{13} +3
(7)	E_{14} +1	E_{14} +1
(8)	F +3	F 0
(9)	G_3 +3	G_2 +2
(10)	G_4 +3	G_4 +1
(11)	H +3	H −1
(12)	K_2 0	J 0

NOTES

C is the only text and chart we have as **A** and **B** have completely disappeared.

0. The presence of what looks like after *rrt* is hard to explain. One expects but it might be an error for . There is room after it for one group, hardly enough for *msḏr iꜣby*.

1. Perhaps restore as in Table 23, 2.

6. The foot of is preserved which eliminates *sḏḥ* as a restoration.

7. Though *pd* is clearly written an emendation to *pt* (as in Table 6, 0, **D**) is required since *sbḳ* precedes. As in Tables 1, 5 and 3, 3, there may be hieratic confusion between and .

9–10. In every other table in which *ꜣpd* appears it covers, as here, two hours. While the first is either *bꜥnt nt ꜣpd, tp n ꜣpd* or *ḥtyt nt ꜣpd*, the second is invariably marked by *kft.f*. It is in the highest degree improbable that there should be no hour star between *bꜥnt* and *sbꜣ n ḫꜣw* in Table 24 and we are forced to emend *bꜥnt* to *kft* in 10. The simplest emendation of 9, then, is to take as an error for . As we shall see in the commentary these emendations are supported by the underlying astronomical facts.

11. We prefer to take the text rather than the location of the star in the chart.

12. The only plausible restoration is *sꜥr*.

COMMENTARY

In 1500 B.C. III *šmw* 16 was July 31 greg. A comparison of Table 23 with Table 24 reveals unmistakably that one or both are corrupt and we have omitted a diagram. The first step must therefore be to compare Table 24 with Table 1 as a check on the accuracy of the former in its emended form. This is done in Fig. 15 and the result is such as to inspire confidence. We have to recall that the epagomenal days separate the two tables. The fact that Table 24 covers not fifteen but twenty days, and the necessary lengthening of some interim hours (the *nḫt*-constellation spans one hour less in Table 1) are quite sufficient to account for the changes and to support Table 24 as being very probably correct.

The next step should be to compare Tables 22 and 24 to see what might best fall between them but before doing so we should like to direct attention to Fig. 16 which is a section of Fig. 5 with the sunrise and sunset lines reversed so that the star lines have the same direction as in the diagrams for the tables. For every individual table the nights are evenly divided into twelve hours (which surely was not so in actual practice) and the stars for the 12th hour are assumed to lie exactly on the line of darkness (though some of them surely fell in the twilight zone); nevertheless when the lines of the 12th hour stars are carried down to intersect with the hour-line of Table 1 it is at once clear that all of the stars which are found as hour stars in Table 1 are fairly near their correct hour mark, the worst off in this respect being E_{10} which is closer to the 2nd hour than to the 3rd. Of particular interest, it should be noted in passing, is the fact that because of the very short nights at this time of year the 12th hour star in each table is generally closer to the 10th hour of each succeeding table than to the 11th hour. This explains the jump of the 12th hour star to the 10th hour in Tables 18 and 19, Tables 20 and 21, Tables 24 and 1 (see Fig. 15) and suggests that we should expect the same phenomenon in Tables 22 and 23 and Tables 23 and 24, if we can reconstruct Table 23.

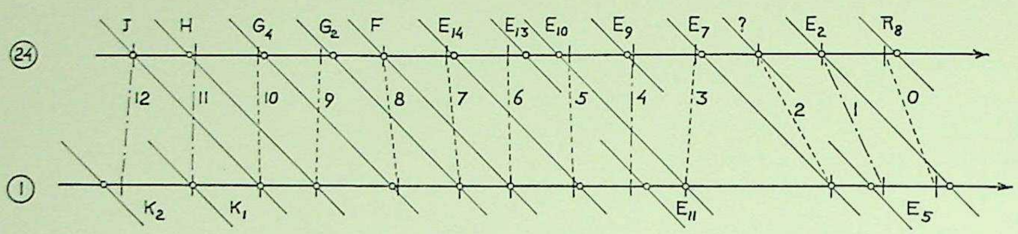
In Fig. 17 the hour lines which connect directly Tables 22 and 24 serve as guides to a possible Table 23. For (0) we accept R_6 at +2, as given. The first hour of Table 22 must have been short so that when R_6 moved up it would be necessary to delay its marking the beginning of the night. E_1 cannot be correct at (1) since that would mean a jump of two hours, not attested elsewhere and *a priori* improbable, and moreover R_8 is at (0) in Table 24. We therefore suggest E_1 for (2) at 0 as given and introduce R_8 at (1), position uncertain.

We then follow E_1 with the same number of stars which follow it to F in Table 22 by introducing E_2, position uncertain. This places F at (10) midway between Table 22's (12) and Table 24's (8), and this is supported by Fig. 16, while Fig. 17 shows that no problems arise with the E stars. After F we add G_3 and G_4 which follow F in Table 23, thus eliminating H and K_2 which have now no place. G_4 at (12) is nicely confirmed by Fig. 16 since it is at 10 in Table 24 and at (8) in Table 1. In every case we retain the position of the star as given. What our emendation amounts to then is dropping the last two stars of the table, inserting R_8 and E_2 and keeping the positions of the retained stars.

This presents some curious features, such as F skipping an hour with its hour boundary moving to the left, after which it skips another hour and moves to the right and like movements are true of other stars.

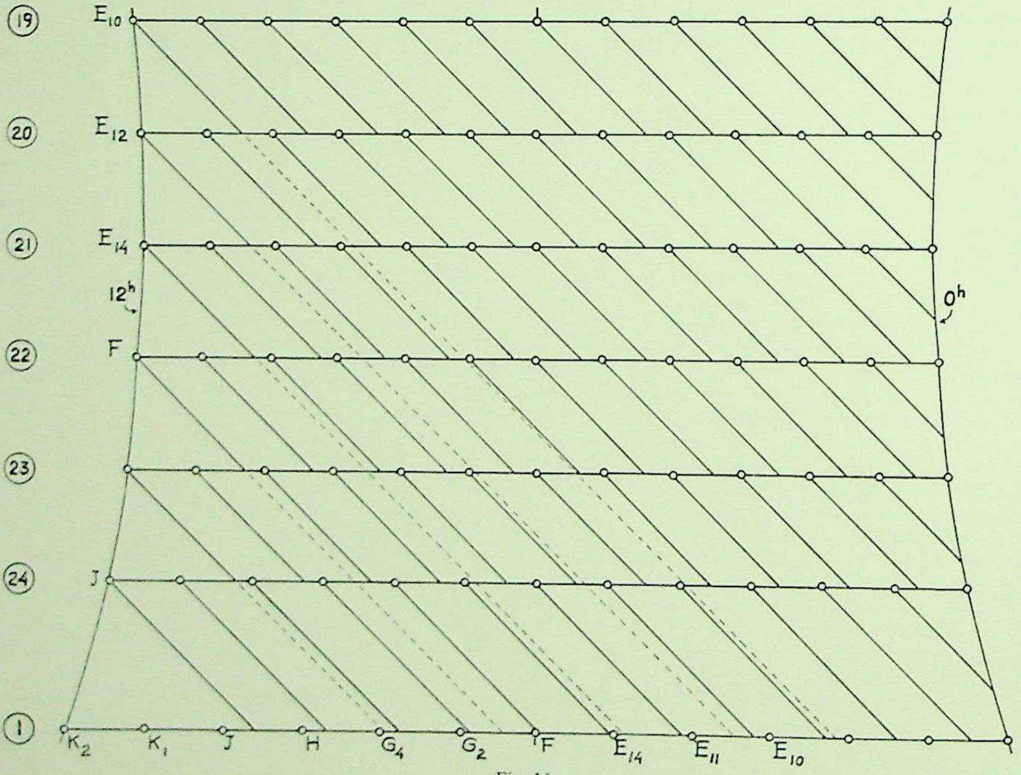
It may be that we should disregard all positions in Table 23 since we cannot be sure that they should go with the star rather than with the hours but our desire is to operate with a minimum of emendation.

To sum up our results we give Table 23 in the emended form we suggest, with Tables 22, 24 and 1 flanking it.



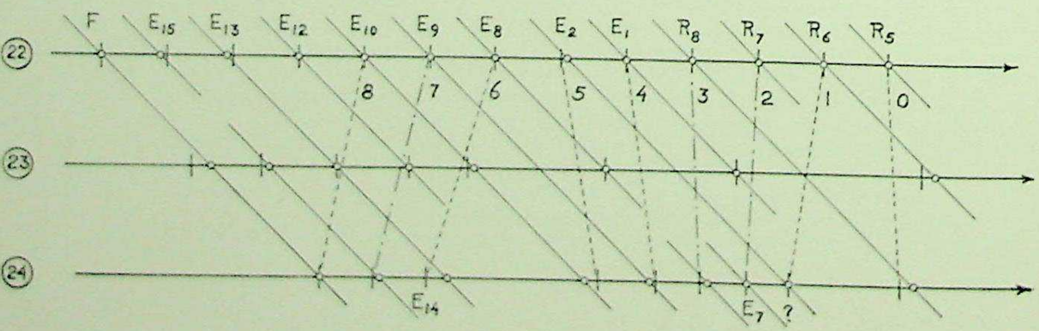
㉔
J
H
G_4
G_2
F
E_{14}
E_{13}
E_{10}
E_9
E_7
?
E_2
$\bar{R}_8$
12
11
10
9
8
7
6
5
4
3
2
1
0
①
K_2
K_1
E_{11}
E_5

Fig. 15



⑲
E_{10}
⑳
E_{12}
㉑
E_{14}
12^h
0^h
㉒
F
㉓
㉔
J
①
K_2
K_1
J
H
G_4
G_2
F
E_{14}
E_{11}
E_{10}

Fig. 16



F
E_{15}
E_{13}
E_{12}
E_{10}
E_9
E_8
E_2
E_1
$\bar{R}_8$
$\bar{R}_7$
$\bar{R}_6$
$\bar{R}_5$
㉒
8
7
6
5
4
3
2
1
0
㉓
㉔
E_{14}
E_7
?

Fig. 17

Table 23

(emended)

IIII *šmw* 1

(0)	*mndt n rrt*	⟨*msḏr iꜣb*⟩*y*
(1)	⟨*šwty.s*⟩	. . . . .
(2)	*tpy-ꜥ šwty nt* ⟨*nḫt*⟩	*ꜥḳꜣ ib*
(3)	⟨*šwty nt nḫt*⟩	. . . . .
(4)	*ḥḏ nt nḫt*	*ꜥḳꜣ ib*
(5)	*ẖꜣ*⟨*b*⟩*.f*	*ꜥḳꜣ ib*
(6)	*bgs.f*	*irt iꜣby*
(7)	*pd.f*	*ꜥḳꜣ ib*
(8)	*sbḳ.f*	*ꜥḳꜣ ib*
(9)	*pt.f*	*irt iꜣby*
(10)	*ꜥryt*	*ḳꜥḥ iꜣby*
(11)	*ḥtyt nt ꜣpd*	*ḳꜥḥ iꜣby*
(12)	*kft.f*	*ḳꜥḥ iꜣby*

	Table 22	Table 23	Table 24	Table 1
(0)	R_5 0	R_6 +2	R_8 +2	E_2 +2
(1)	R_6 0	R_8 —	E_2 0	E_5 −2
(2)	R_7 0	E_1 0	? 0	E_7 0
(3)	R_8 0	E_2 —	E_7 +1	E_{10} 0
(4)	E_1 0	E_6 0	E_9 −1	E_{11} +3
(5)	E_2 +1	E_8 0	E_{10} −2	E_{14} +1
(6)	E_8 0	E_{10} +1	E_{13} +3	F 0
(7)	E_9 0	E_{12} 0	E_{14} +1	G_2 0
(8)	E_{10} 0	E_{13} 0	F 0	G_4 −1
(9)	E_{12} 0	E_{14} +1	G_2 +2	H 0
(10)	E_{13} −1	F +3	G_4 +1	J 0
(11)	E_{15} −1	G_3 +3	H −1	K_1 0
(12)	F 0	G_4 +3	J 0	K_2 −3

CHAPTER III

CONCLUDING REMARKS

In the preceding chapter we have tried to establish as accurately as possible the archetype of the star clock from the available monuments. In doing so we had to deal with the twenty-four tables more or less individually, though we did compare each table for consistency with the immediately related ones. That the extant text should not contain errors and modifications of the centuries older original can hardly be expected. Nevertheless, we have resisted arbitrary changes to obtain more satisfactory results, even if in some cases it would not be difficult to introduce emendations which would give a more even division of the hours of the night.

Thus taking our text as we have established it, we now can represent the results in a schematic fashion. From the very outset, however, we must warn the reader that the following superposition of individual tables not only contains the insecurities of every individual element but that we are compelled to make additional idealizing assumptions which must modify the factual situation to an unknown degree. All we can hope to obtain is a qualitative representation of the main features of the Egyptian system as a whole.

Each horizontal line corresponds to one of the twenty-four tables in the same fashion as the diagrams in the preceding chapter.[1] The sloping lines are associated with the stars indicated at their beginnings on the left (e.g., it is the star K_1 which indicates by its transits the 11th hour in Table 1, the 10th hour in Table 2, etc.). Since we have no estimate of the influence of the secondary transits we ignore them from now on. We do, however, indicate by a little ring when the transit is declared in the text as seen at the line ‘*ḳꜣ ib*, presumably the meridian. Interruption of a star line indicates that the star does not serve for that table; e.g., Q_2 ends the 11th hour in Table 8, is not used in Tables 9 and 10, but marks the hours 7 to 12 in Tables 11 to 16.

Dotted straight lines connect corresponding hour boundaries. These boundaries are either given for the stars listed (e.g., 10^h to 5^h in Table 2) or lie between two given points two hours apart (e.g., 8^h and 10^h in Table 4). In the latter case the midpoint is chosen for the omitted hour. No hour-lines are given, however, if extrapolations would be involved (e.g., first and last hours in Table 2) or subdivisions for more than two hours (e.g. between 2^h and 5^h in Table 2).

Fig. 18 is based on one assumption: the end of the 6th hour in every table is accurately at midnight. We then wish to see how our star tables would have worked under this idealization which should not misrepresent the facts too much, even in a rather crude system of time reckoning.

To answer our question we simply excerpt from our tables all hours marked in any table by the same twenty-four stars which serve as 6th hour stars. The result is shown in Fig. 18. One sees that, for certain groups of tables and hours, equality of hours results from the fact that consecutive stars which mark midnight in consecutive tables are used for corresponding hours. But, of course, these hours are not the seasonal hours the Egyptians were attempting to indicate and therefore omission of hours or shifts to new stars inevitably produces very uneven hours.

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[1] Cf. p. 15.

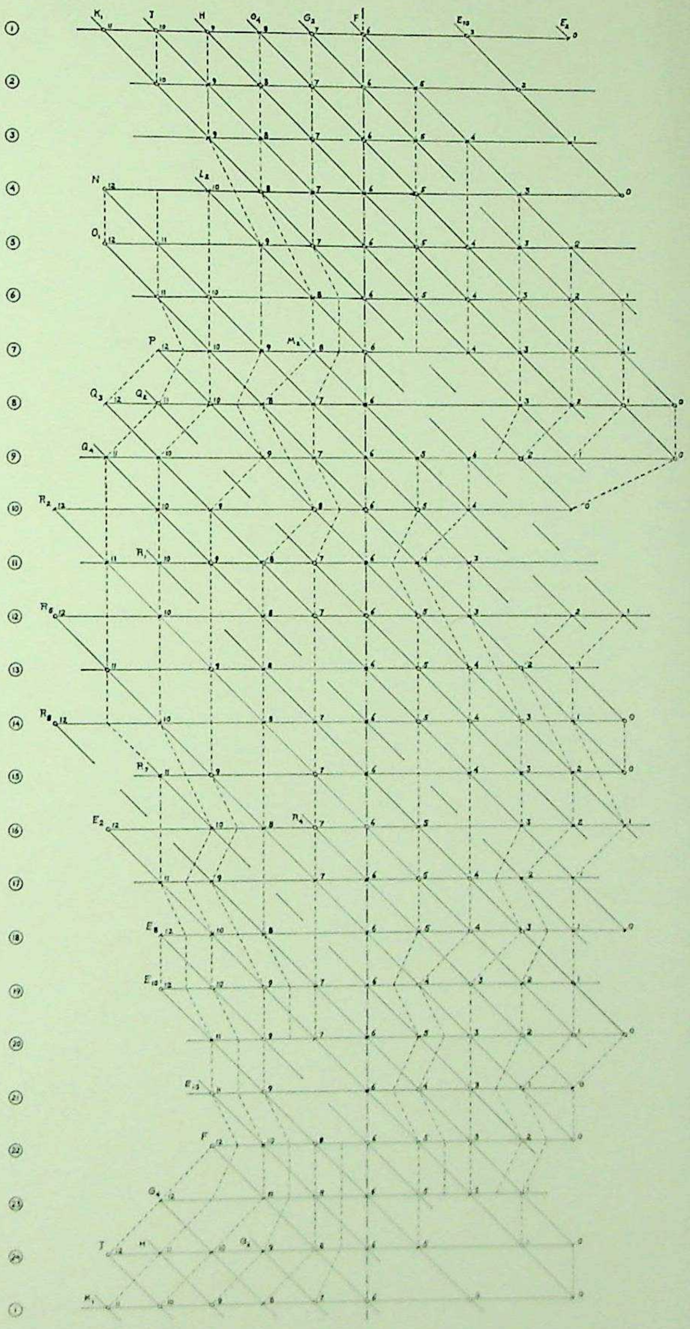

Fig. 18

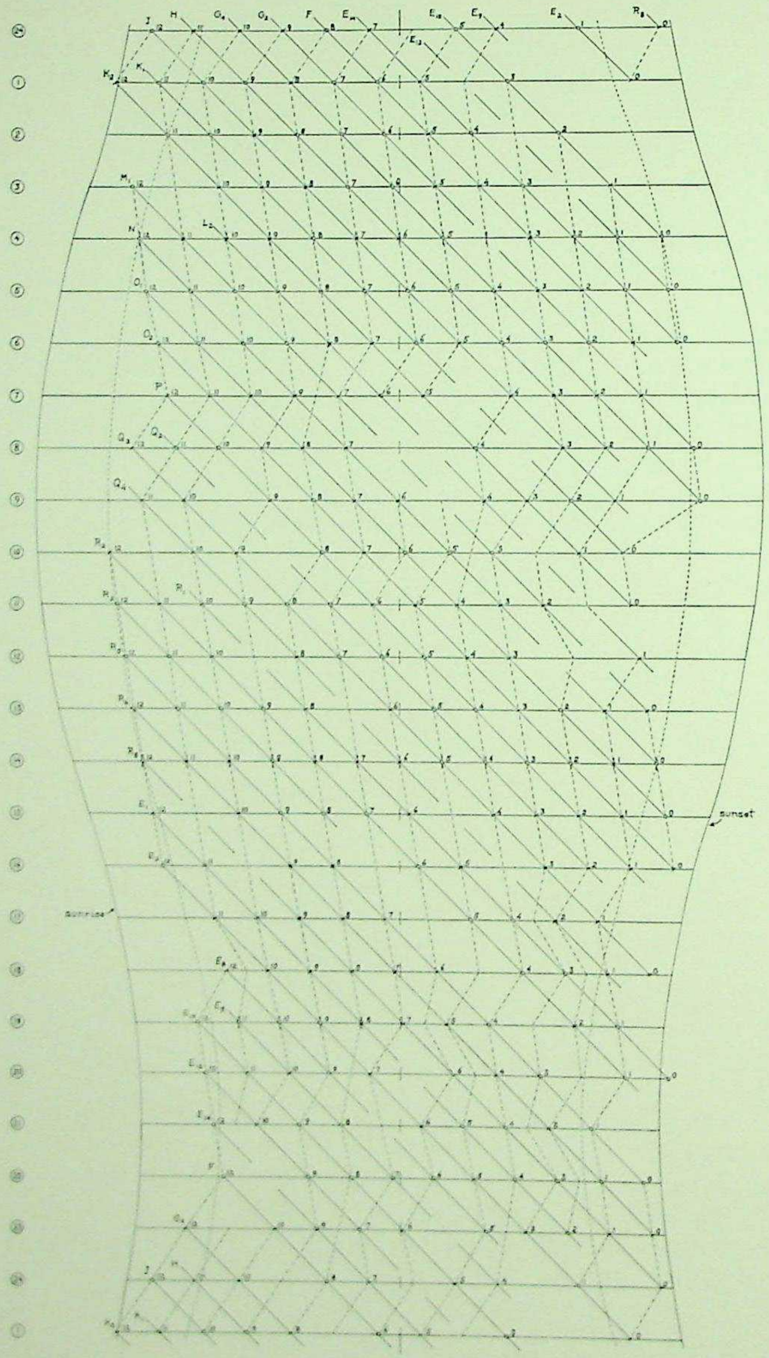
sunset
sunrise

Fig. 19

One result, however, becomes clear from our diagram. Having made in Fig. 18 no assumption whatever concerning the type of hours measured by our texts nor concerning the seasons to which the individual tables belong we find that the longest night must be very near to twelve equinoctial hours in the area of Tables 9 to 12 and that the shortest night of seven equinoctial hours length appears in Table 22. Even if in fact the 6th hour was not accurately located at midnight it is clear that the general picture would not be essentially modified. Thus we have here a new proof that the twelve hours of night did not stretch (as later the Greek "seasonal hours") from sunset to sunrise but were by and large restricted to the period of complete darkness. We also see that our date for the construction of this system is essentially right since the extremal hours should accordingly occur in Tables 9 and 21, or 10 and 22, if we allow a margin of about half a century.

Having now demonstrated that the variation of the length of night must be essentially governed by the period of complete darkness we construct another figure operating with a different type of idealization which probably deviates in detail from the actual facts more often than the assumption of Fig. 18. Nevertheless, certain features will be again qualitatively correct and will complete our insight into the working of the Egyptian mechanism.

We assume now that at least one star indicated not only the end of the 12th hour correctly but also the beginning of the first hour, ten tables later. It is easy to find such a star on the basis of our graph of the end of twilight (dotted curve in Fig. 19), namely star N between Tables 4 and 14.

We then assume that the hours for the two tables where the end-points are correct are of equal length; i.e. we assume that the water clocks which had to be used to select the proper stars at each hour worked fairly well for Table 4 and Table 14. Undoubtedly this is a very optimistic assumption but any attempt to indicate margins of errors would be purely arbitrary. Thus we may just as well operate with ideal mean values.

From here on we follow the texts for all stars which indicate hours in Tables 4 and 14.[1] Unfortunately this process cannot cover all our tables since from the last hour in Table 14 on until E_{10} in Table 19 our previous assumptions are without influence. Thus we have to fill the gap by an additional group of stars which we select as follows. We follow the last star, R_8, of Table 14 to Table 19 where it indicates the 7th hour. If we use the length of the hours 1 to 7 for this table to estimate the end of the 12th hour we come very close to E_{10} and to the end of twilight. This we take as indication that E_{10} is in a fairly correct position. We assume again an even distribution of the hours 8 to 12 in Table 19. This then provides us with the positions of the stars needed between R_8 determined by Table 14 (12^h) and E_{10} determined by Table 4 (0^h) in order to complete our diagram.

Again we see that the agreement with the twilight limit remains fairly close except for the evening hours from Tables 16 to 1. The twilight limit is best observed at the end of the night. At the beginning of night more stars reach into the zone of partial darkness. R_1 in Table 20 is clearly impossible since the zero hour would begin before sunset. Obviously our scheme is too rigid to be taken seriously in every individual case.

By and large, however, our diagram illustrates clearly enough how a comparatively accurate division of the night had to be modified over and over again when the discrepancy became too great between hours indicated by stars from a preceding table and the twilight limits. It is also clear that no consistent scheme had been constructed to overcome this difficulty – otherwise the insertion or dropping of stars would show a much more regular pattern, involving many more stars than actually used in our texts. Thus we see here the results of an ill-conceived scheme which attempted to combine contradictory elements, namely star transits and seasonal hours. Adding to this the effects of a rotating calendar must have given rather disastrous results. Yet the device seems to have appeared so profound and effective that it became destined to indicate the hours of night for all eternity on the ceiling of the Ramesside tombs.

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[1] In Table 4 we substitute G_2 for G_1 which appears only in this table.

LIST OF ABBREVIATIONS

(Supplementary to Volume I)

B. M.	British Museum.
Champollion, *Not. Descr.*	Jean François Champollion, *Monuments de l'Égypte et de la Nubie. Notices descriptives conformes aux manuscrits autographes rédigés sur les lieux par Champollion le Jeune*. 2 vols. (Paris, 1844).
EAT I	O. Neugebauer and Richard A. Parker, *Egyptian Astronomical Texts. The Early Decans.* Brown Egyptological Studies III. (Providence, 1960).
Gardiner, *AEO*	Alan H. Gardiner, *Ancient Egyptian Onomastica*. 2 vols. of text, 1 vol. of plates (Oxford, 1947).
Lepsius, *Denk.*	Richard Lepsius, *Denkmäler aus Aegypten und Aethiopien nach den Zeichnungen der von Seiner Majestät dem Könige von Preussen Friedrich Wilhelm IV nach diesen Ländern gesendeten und in den Jahren 1842–1845 ausgeführten wissenschaftlichen Expedition*. 12 vols. (Berlin, 1849–1859).
Le Page Renouf, *Life-work*	Sir Peter Le Page Renouf, *The Life-work of Sir Peter Le Page Renouf*. 4 vols. (Paris, 1902–1907).
TSBA	*Transactions of the Society of Biblical Archaeology*.
Urk. V.	Herman Grapow, *Religiöse Urkunden nebst deutscher Übersetzung*. 3 fascs. (Leipzig, 1915–1917).

SUBJECT INDEX

The numbers refer to the pages

bird (constellation) 5, 6, 27
Clère 33
date of the tables 9, 29, 31, 33, 39, 73
decans 3
Gensler ix
giant (constellation) 5, 23, 61
hippopotamus (constellation) 5, 7
hour stars 4
Le Page Renouf ix, 9 n.3
lion (constellation) 5, 7
mooring post (constellation) 5
Orion 5, 6
Schack-Schackenburg ix, 9 n.3
seasonal hours 73
Sirius 4, 6
transits 16
twilight 73

ADDITIONS AND CORRECTIONS TO VOLUME I

p. vii, note 2. Other published Egyptian astrological texts, which we failed to mention, are O. Neugebauer, "Demotic Horoscopes", *JAOS* 63 (1943), pp. 115–27, and George R. Hughes, "A Demotic Astrological Text", *JNES* 10 (1951), pp. 256–64.

p. 3, lines 5 and 6. Correct *ʿryt* to *ʿrt*. There is an hour star *ʿryt* (*supra*, p. 6) and *Wb.*I, p. 209, has confused it with the decan *ʿrt* which is never written with *i* or *y* until the latest period.

p. 7, note 2. The De Buck reference should be deleted as it refers to S3P, Coffin 9.

p. 9, line 11, *add*. For the general coffin texts, cf. De Buck, *CT*, text S2Chass.

p. 10, bottom line. Correct *ʿryt* to *ʿrt*.

p. 11, line 2. Correct *ʿryt* to *ʿrt*.

p. 12, line 7 and note 2. The Oriental Institute photographs listed all represent G1T. It is known that while Gardiner and De Buck copied G1T from photographs they both collated their copies with the original. The note refers to G2T only.

p. 13, line 1. Correct *ʿryt* to *ʿrt*.

p. 15, line 3. Correct *ʿryt* to *ʿrt*.

p. 17, *after* line 8 *add*. For the general coffin texts, cf. De Buck, *CT*, S9C.

p. 24, *after* Nos. 24–25. Correct all *ʿryt*'s to *ʿrt*.

p. 41, line 28. Correct the last + to =.

p. 56, line 17. Correct *wnmt* to *wnwt*.

p. 57, notes to III, 3 on *ḥs*. T. G. Allen suggests a consideration of Gardiner's rendering 'to turn back, to turn homeward' in *AEO* I, pp. 159*–60*. Used in Dynasties XVIII and XIX as "the technical term . . . for the homeward turn after the culminating point of an expedition" this meaning would not be unsuitable for the star in the west, finished with work and approaching the Duat. But *ḥs* is also used in III, 6 of the passage of the star in the Duat toward the day of rising and here the suggested meaning is less appropriate.

p. 59, line 17. Correct [*nꜣy*] to [*nꜣw*].

p. 60, Text Bb. It should have been noted that this text is a palimpsest like Text Aa and the comment to the latter on p. 62 applies here as well.

p. 67, line 16. T. G. Allen suggests that *sṭsw Šw* should be rendered 'the uplifted of Shu' (= the sky) rather than 'the supports of Shu', with reference to Grapow in *Urk.* V, translation pp. 3, 12. This would suit V, 25 well (p. 71) and we accept it.

p. 71, line 13. See the preceding comment.

p. 86, *before* Concordance Number 24. Correct *ʿryt* to *ʿrt*.

p. 88, line 2. Correct 'follow' to 'follows'.

p. 115, line 22. Correct *ʿryt* to *ʿrt* (twice).

p. 134, line 17. Correct 'Canopis' to 'Canopus'.

NOTES TO THE PHOTOGRAPHS

A Tomb of Ramses VI, Hall E
B Tomb of Ramses VI, Corridors A and B
C Tomb of Ramses VII
D Tomb of Ramses IX
For details cf. pp. 1–3
(b) blue filter
(r) red filter
(y) yellow filter
otherwise panchromatic film.

In order to obtain reproductions of complete units it was often necessary to combine photos taken from different positions resulting in some unavoidable discontinuities at the joins.

The rows of circles which often cross the pictures are wasp nests.

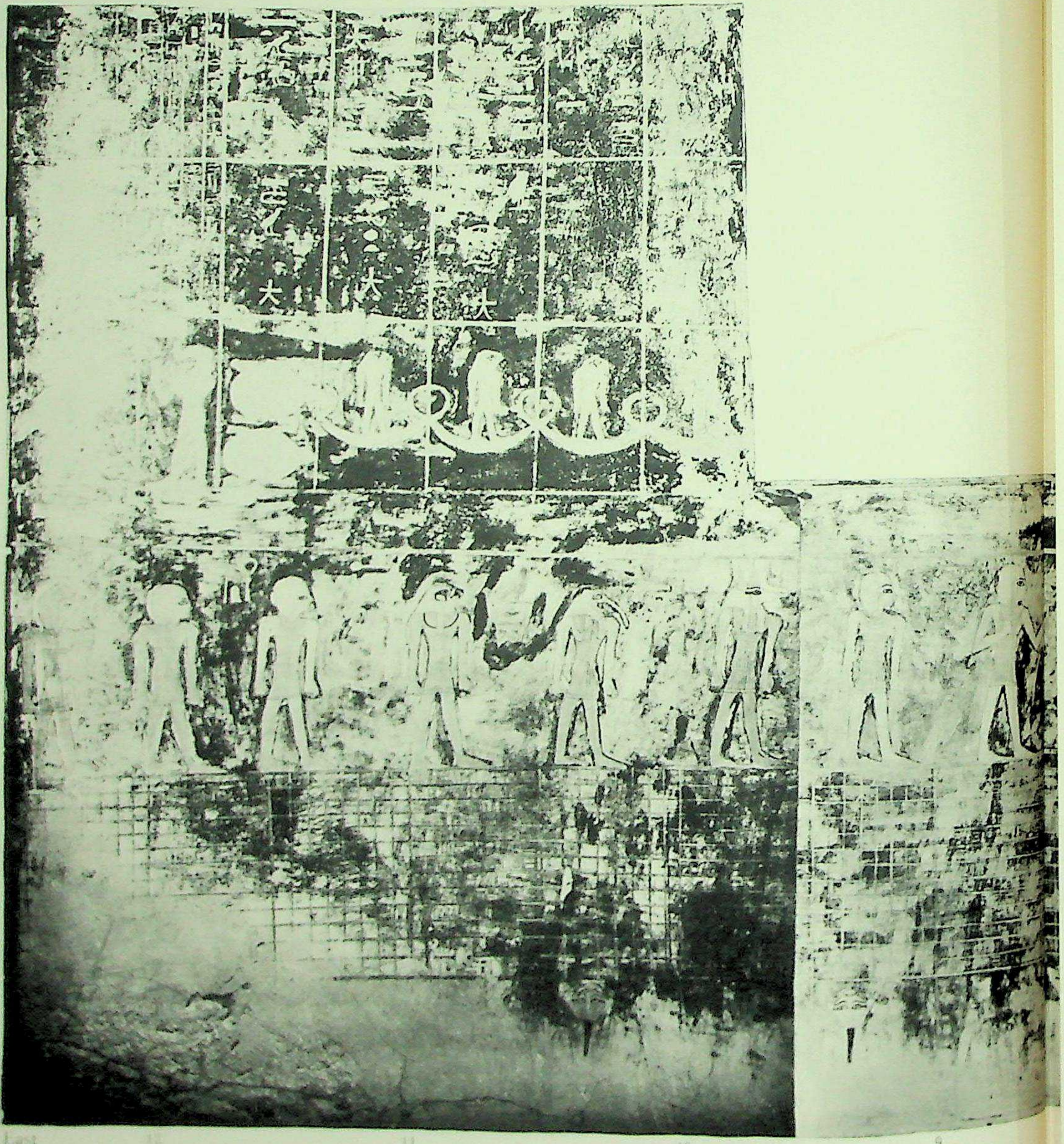
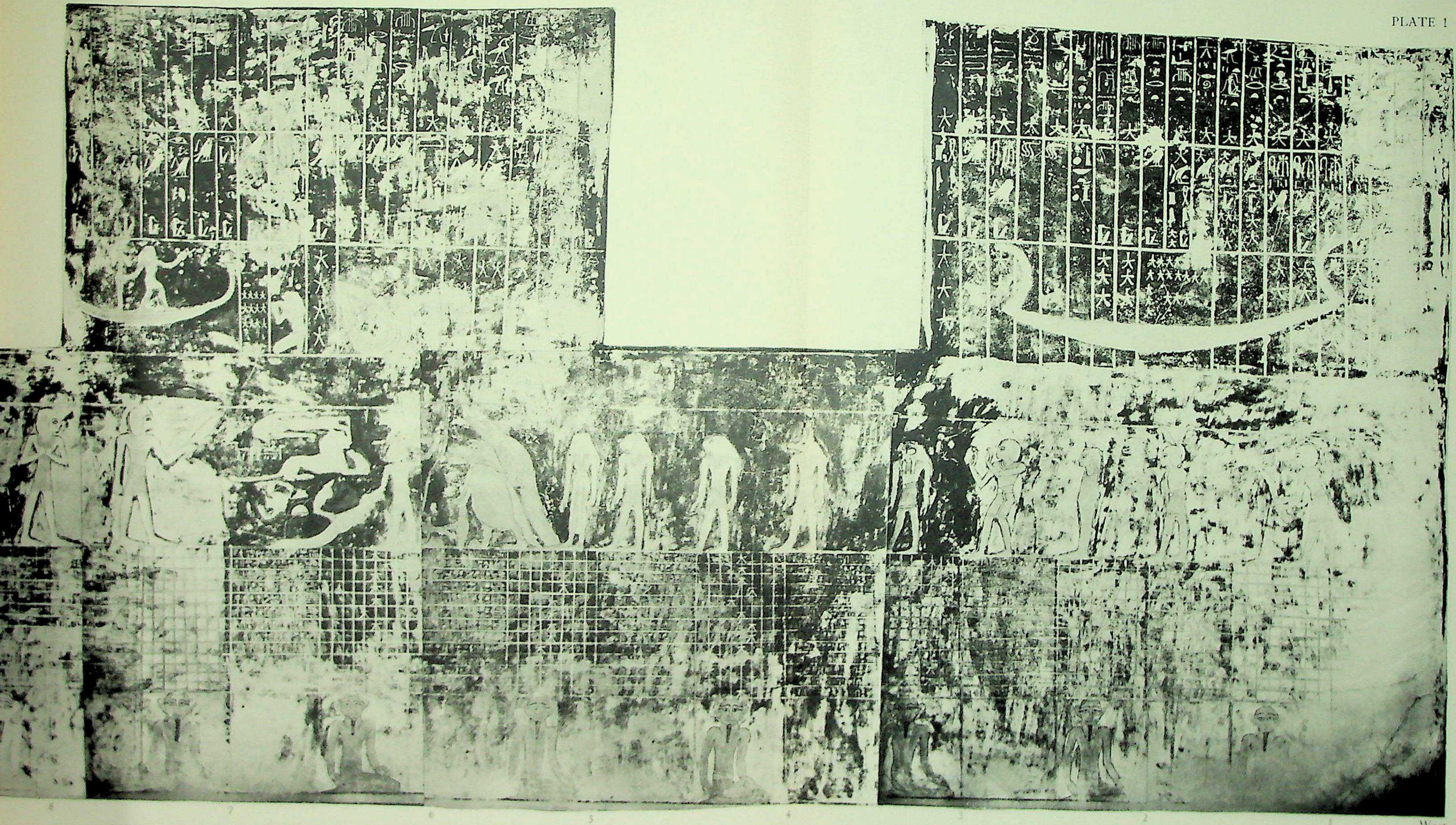

East
12
11
10
9

PLATE 1


8
7
6
5
4
3
2
1
West

TOMB OF RAMSES VI. CEILING OF HALL E, SOUTH

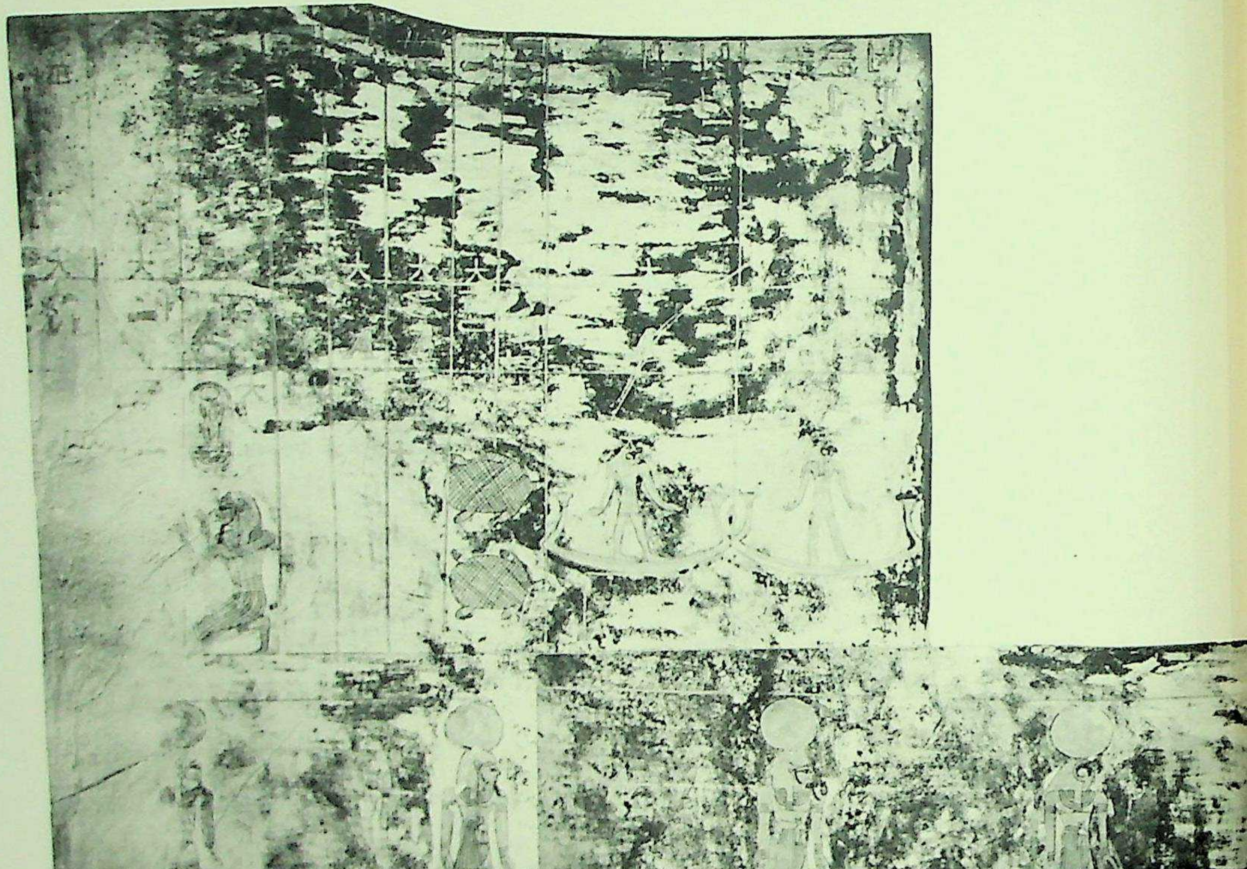
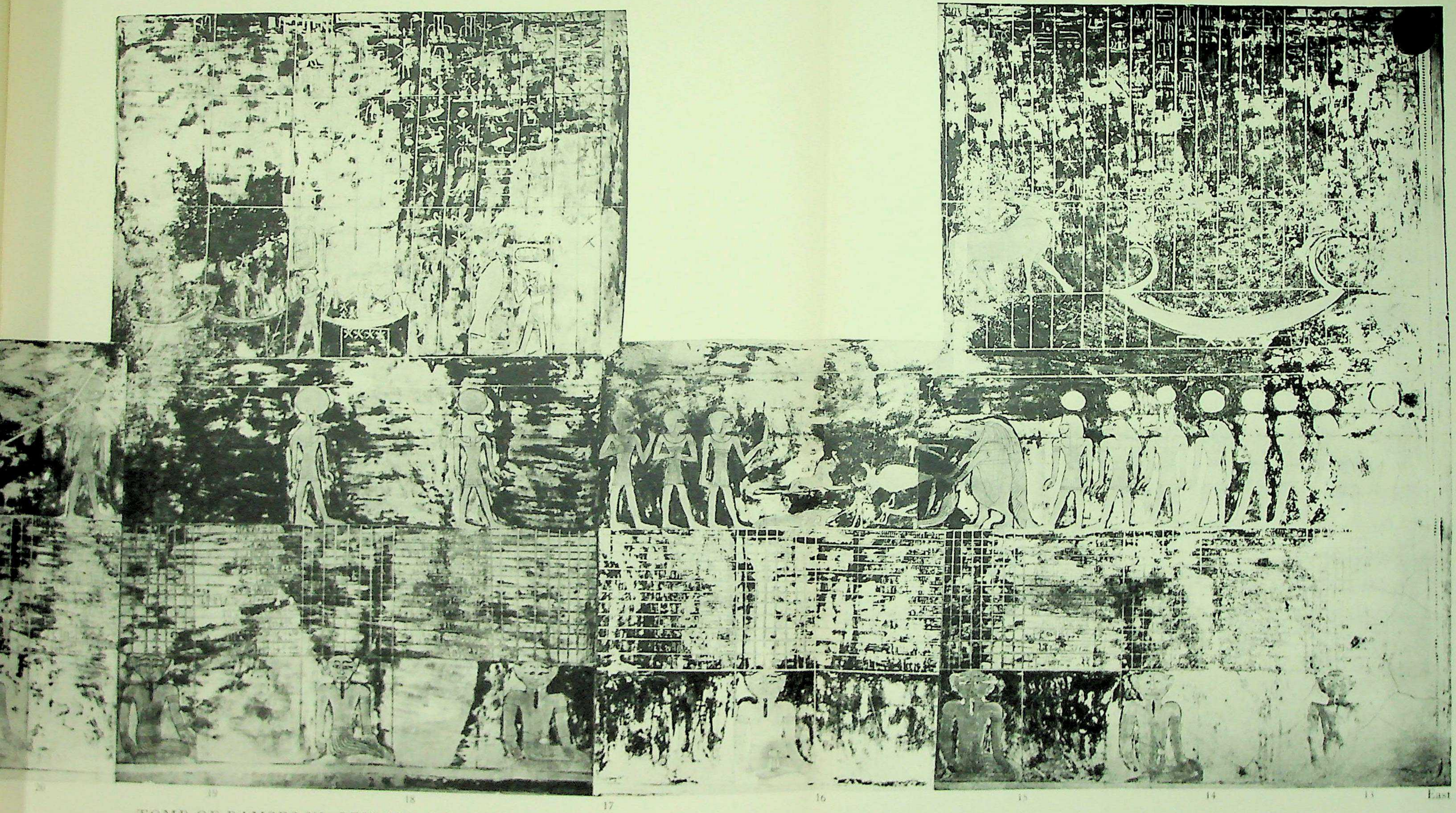
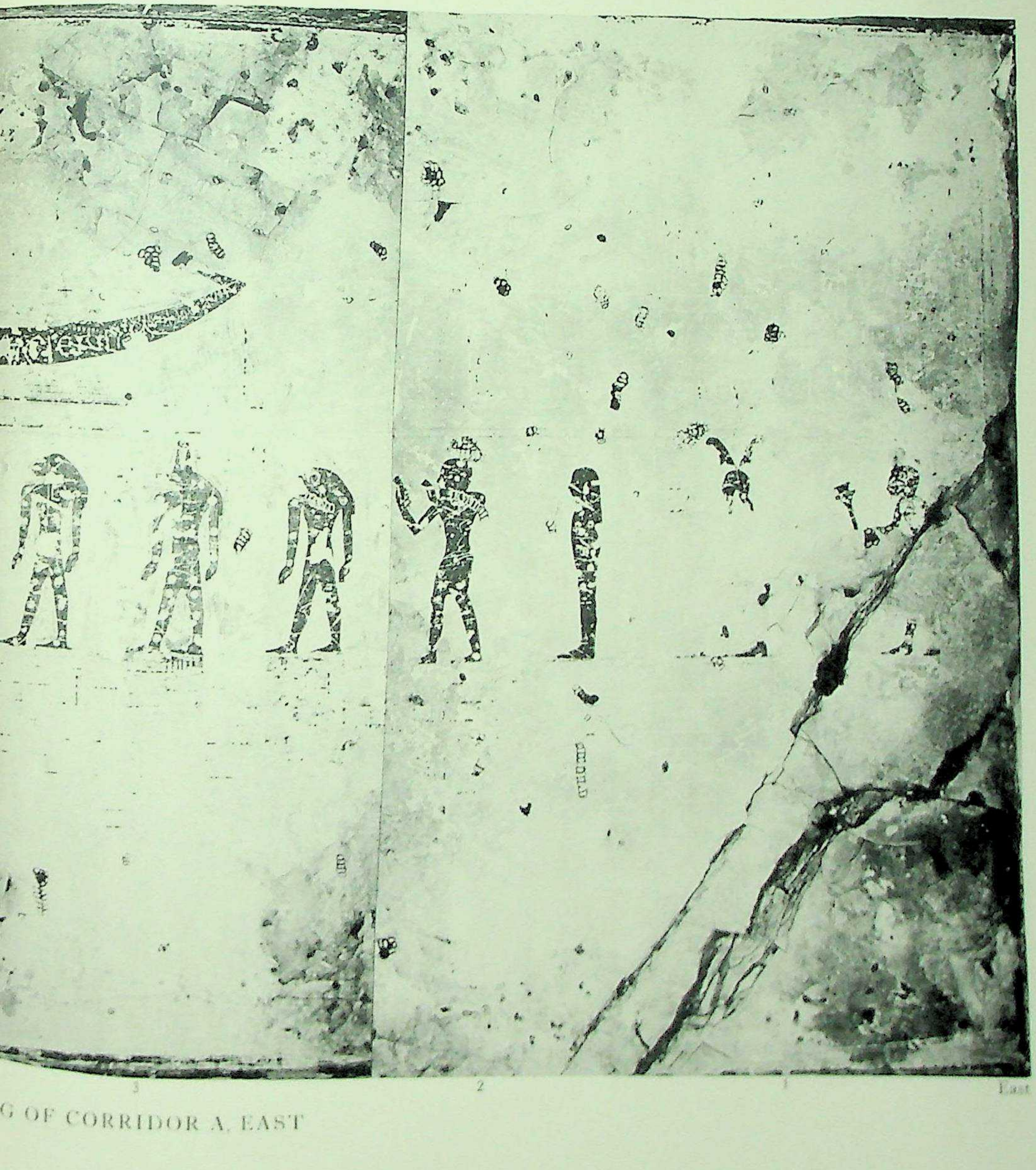

West
24
23
22
21

PLATE 2

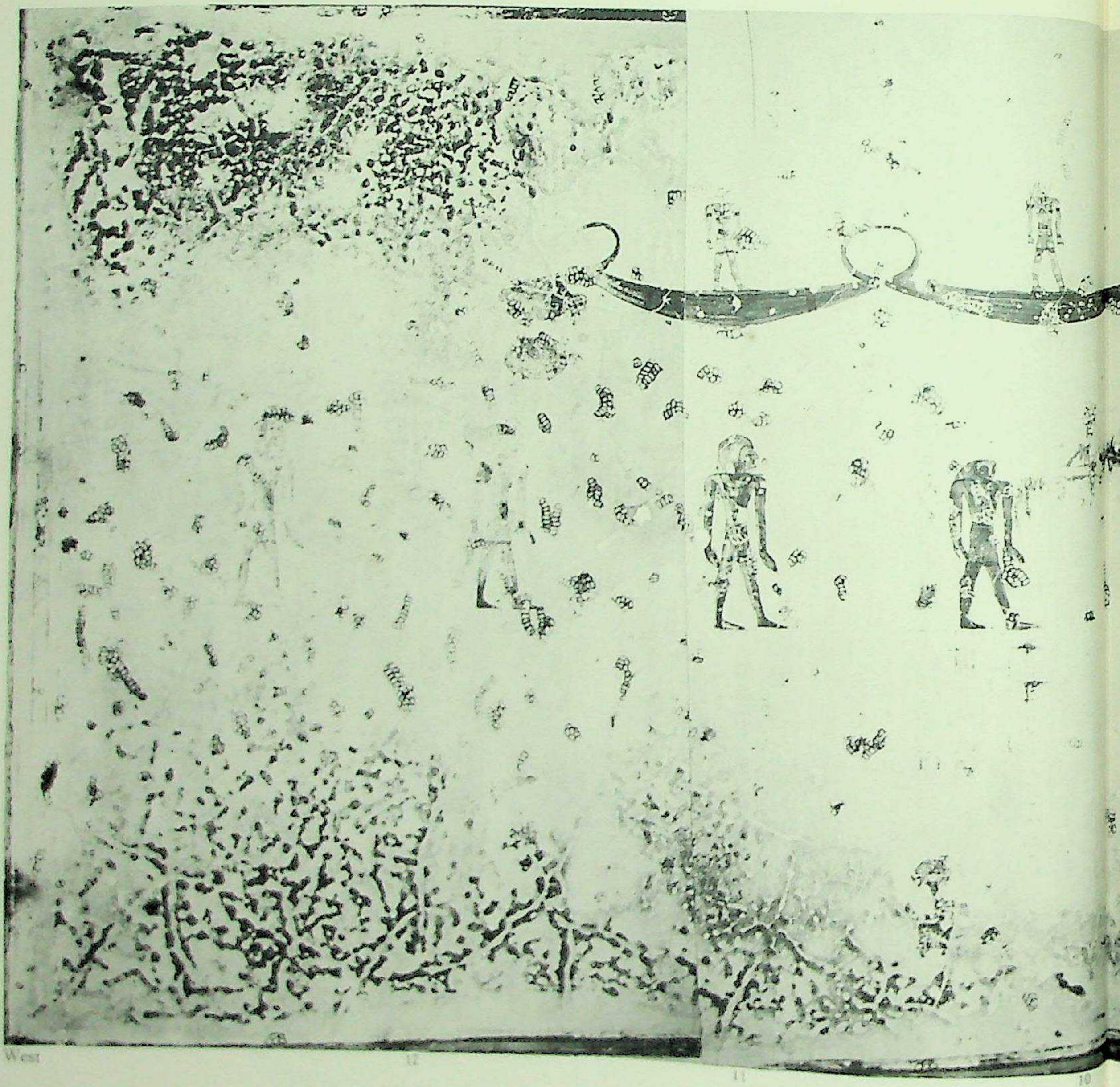

20
19
18
17
16
15
14
13
East

TOMB OF RAMSES VI, CEILING OF HALL E, NORTH

TOMB OF RAMSES VI, CH

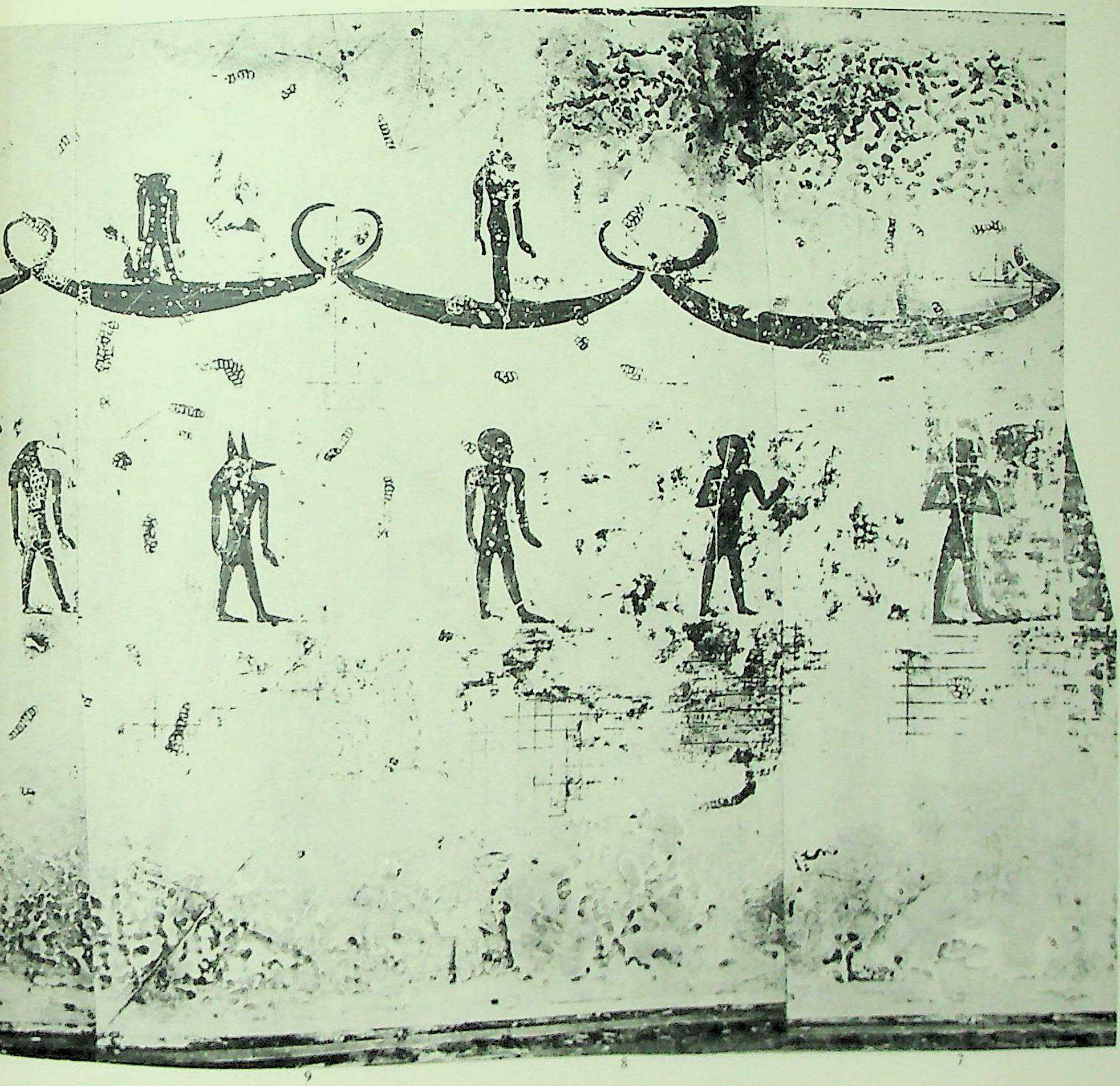


G OF CORRIDOR A, EAST

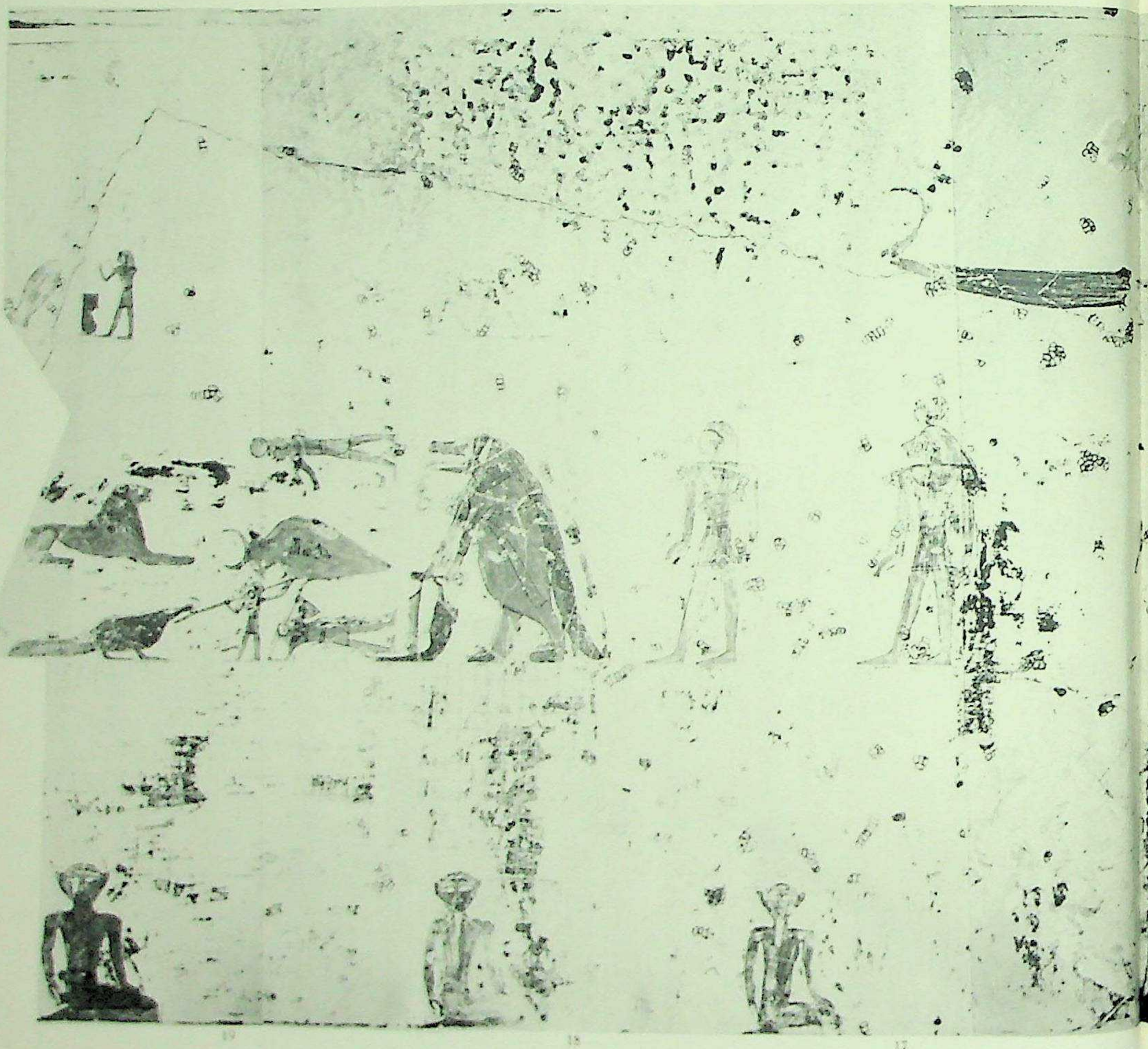

West
12
11
10

TOMB OF RAMSES VI, CE

PLATE 4

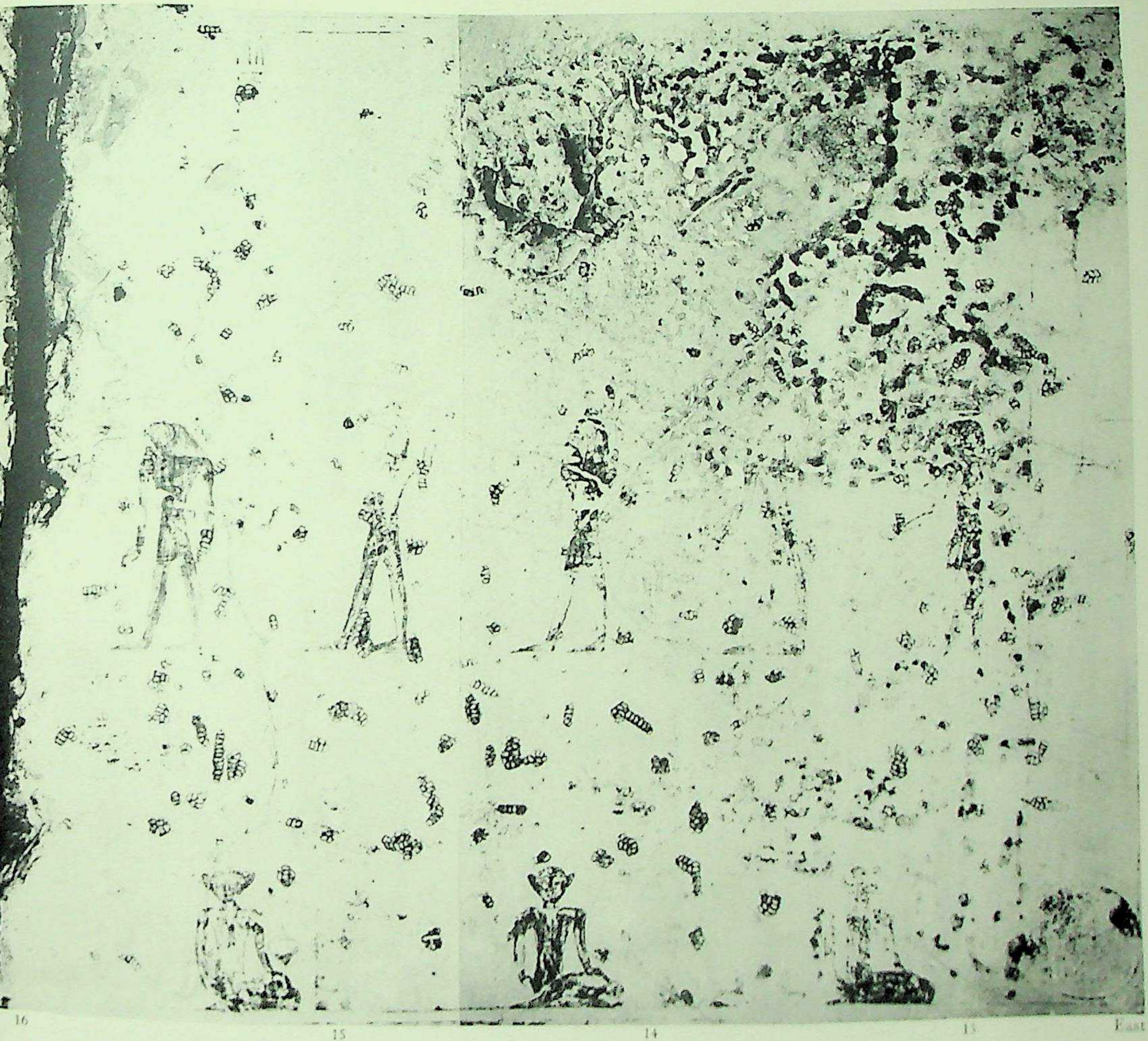


OF CORRIDOR A, WEST



TOMB OF RAMSES VI,

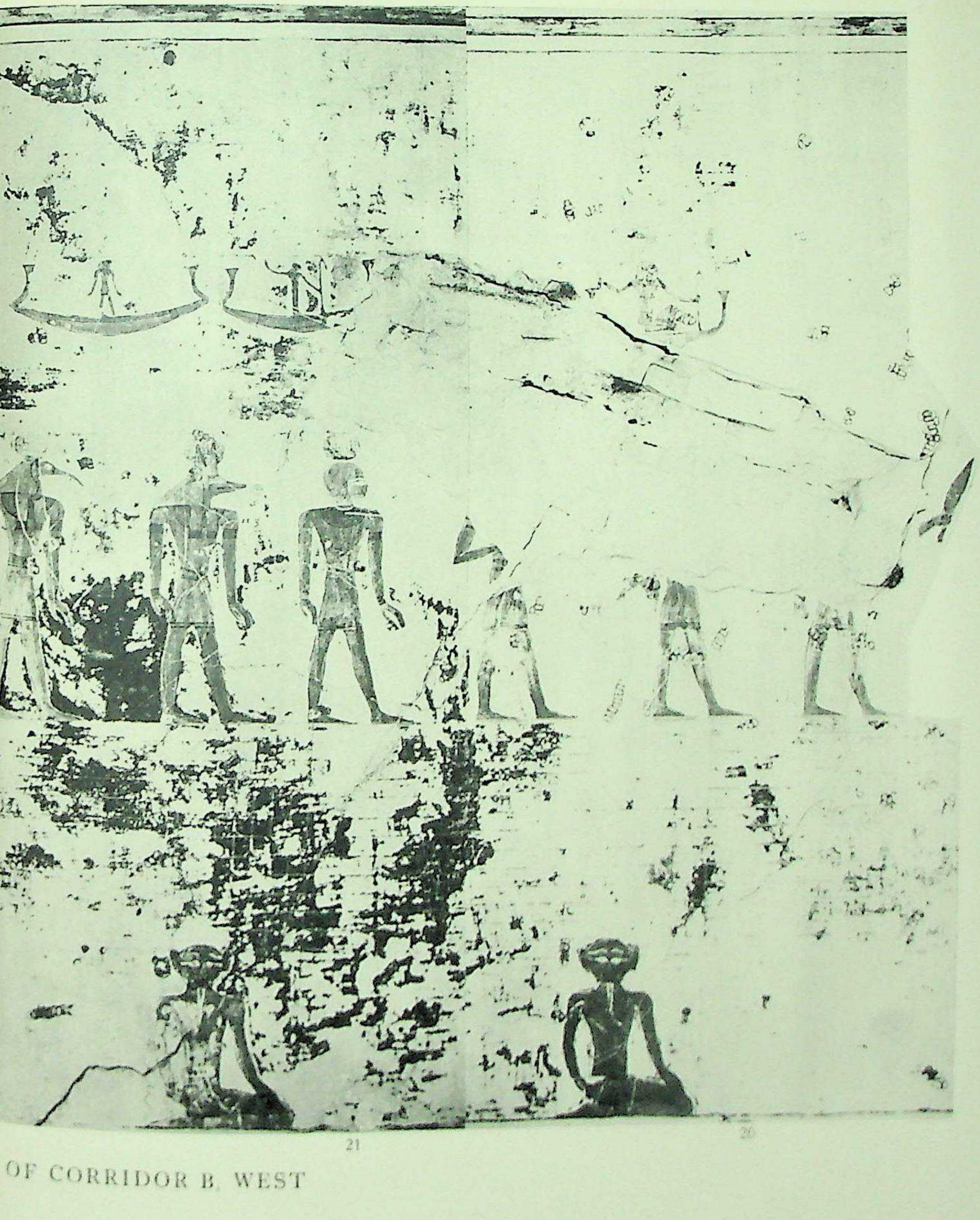
PLATE 5


16
15
14
13
East

NG OF CORRIDOR B, EAST

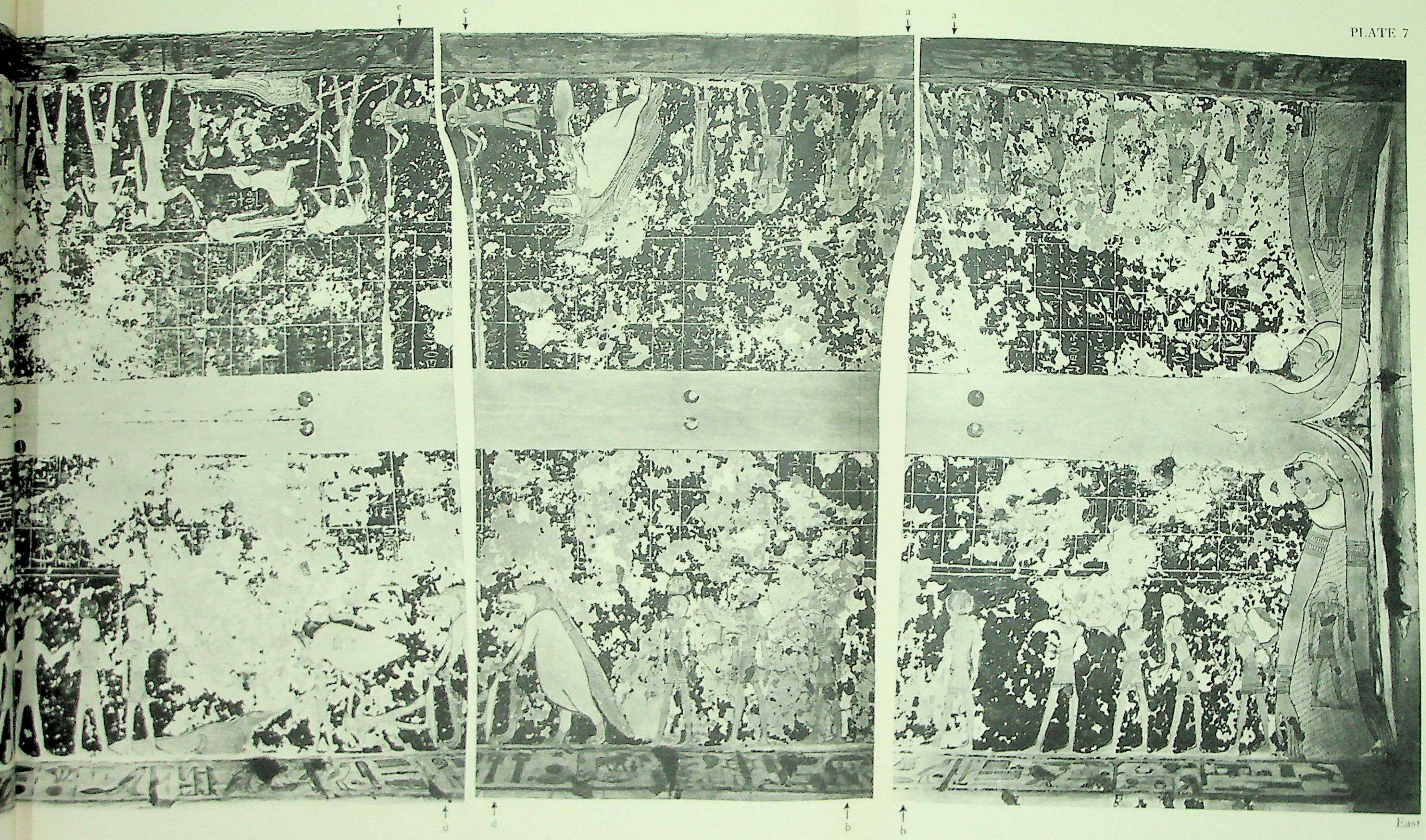
TOMB OF RAMSES VI, CEI

PLATE 6



OF CORRIDOR B, WEST

PLATE 7


c
c
a
a
d
d
b
b
East

TOMB OF RAMSES VII, VAULT OF CEILING OF HALL B

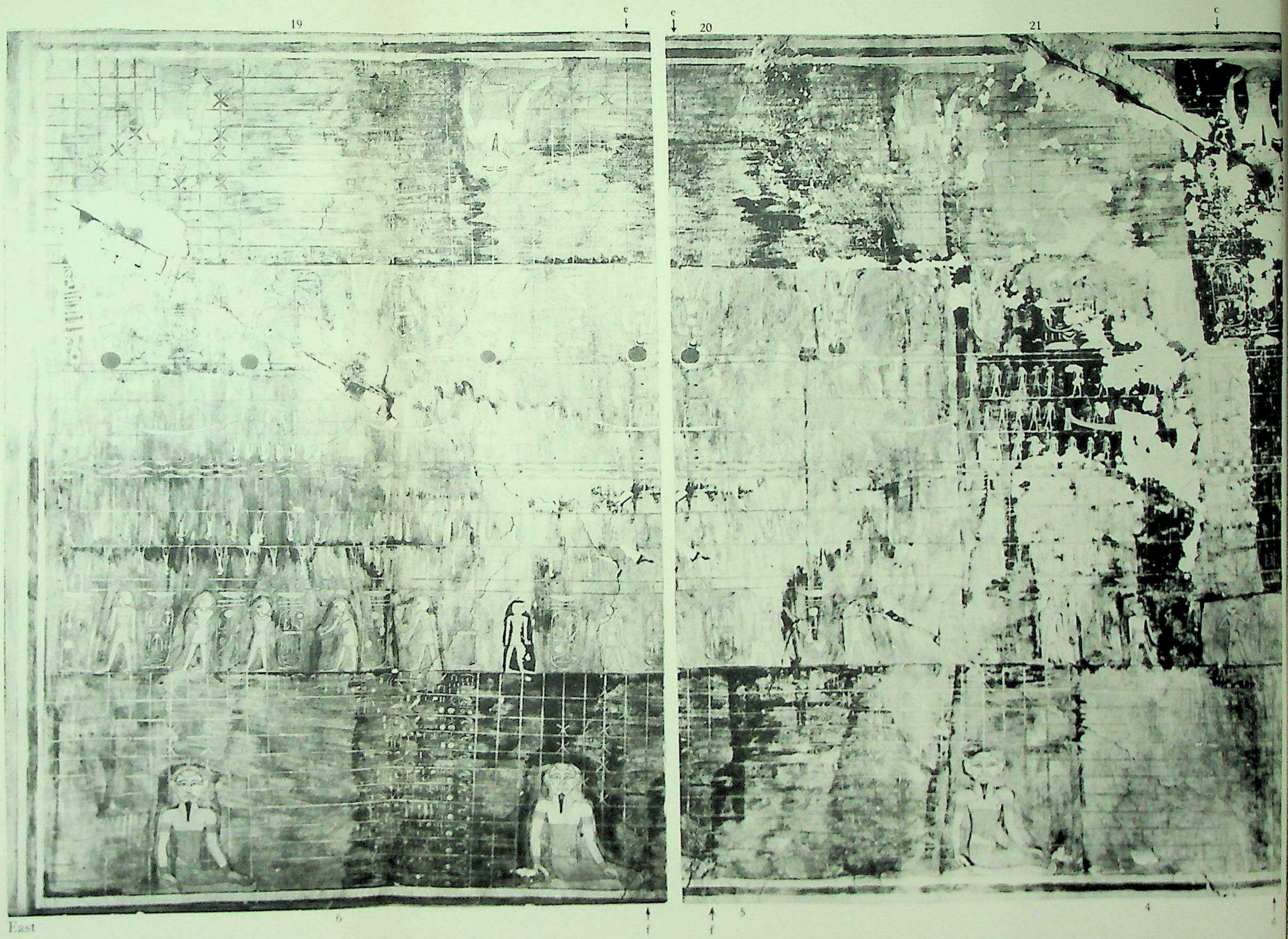
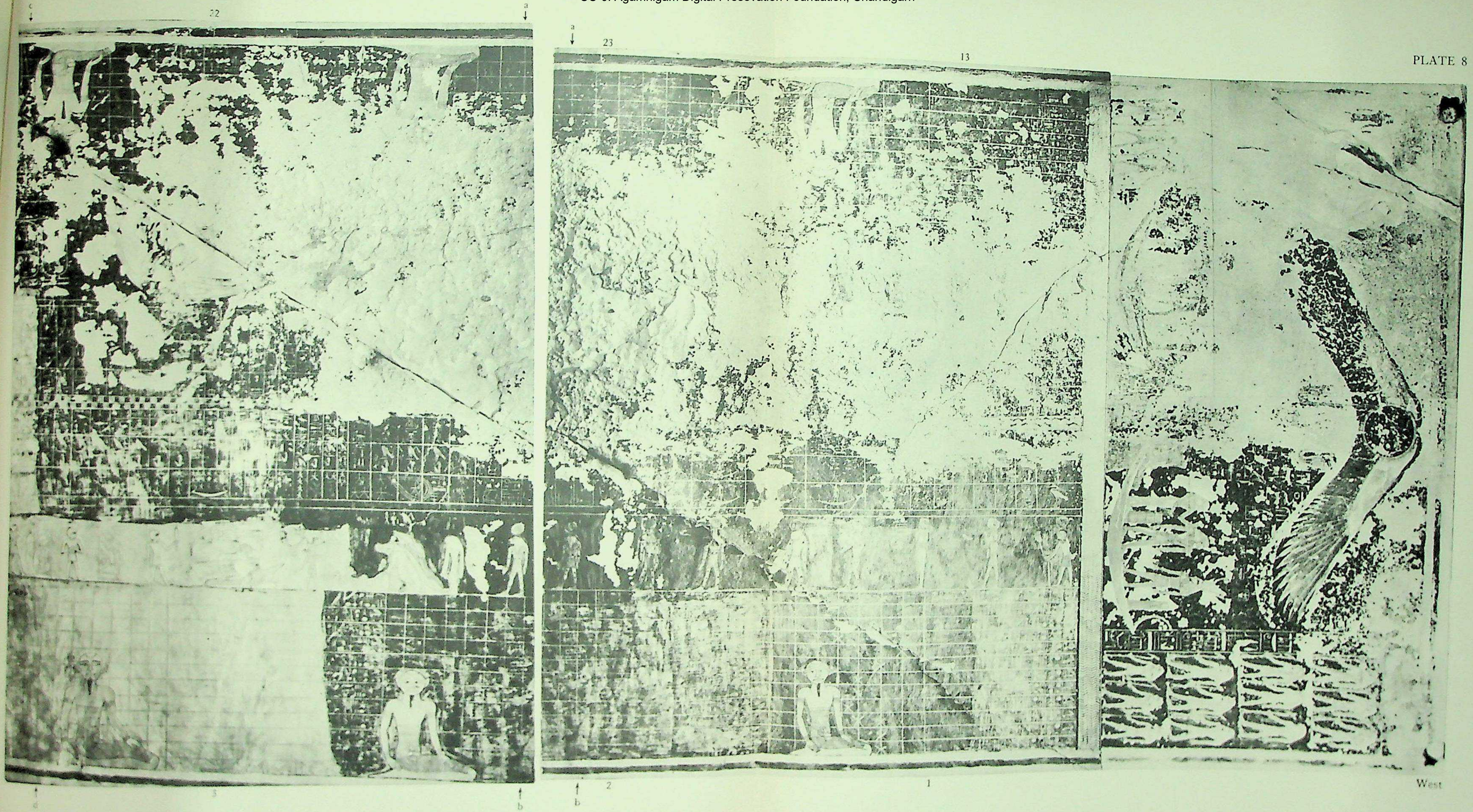
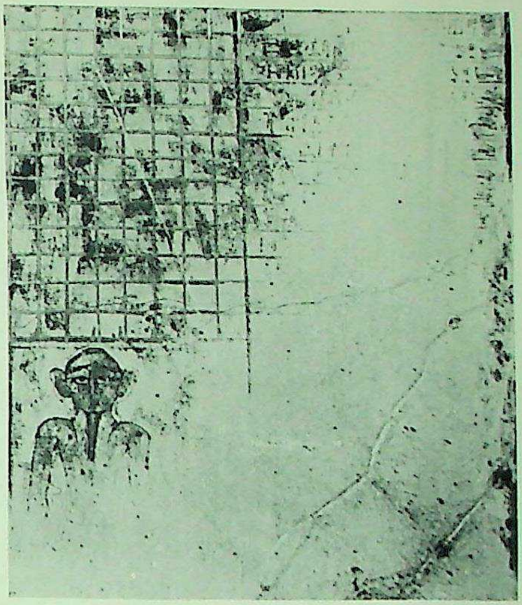

19
e
e
20
21
c
East
6
f
f
5
4
d

PLATE 8


c
22
a
a
23
13
d
3
b
b
2
1
West

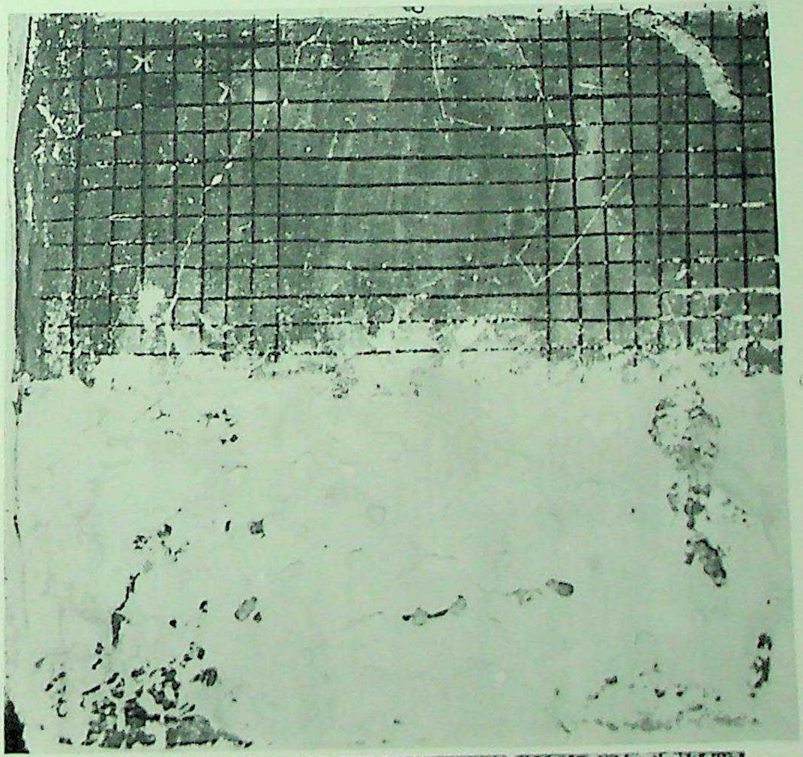
TOMB OF RAMSES IX, CEILING OF CORRIDOR B

B
see Plate 3

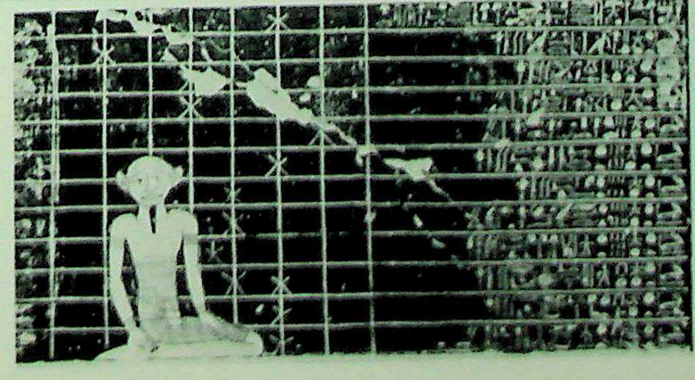


A

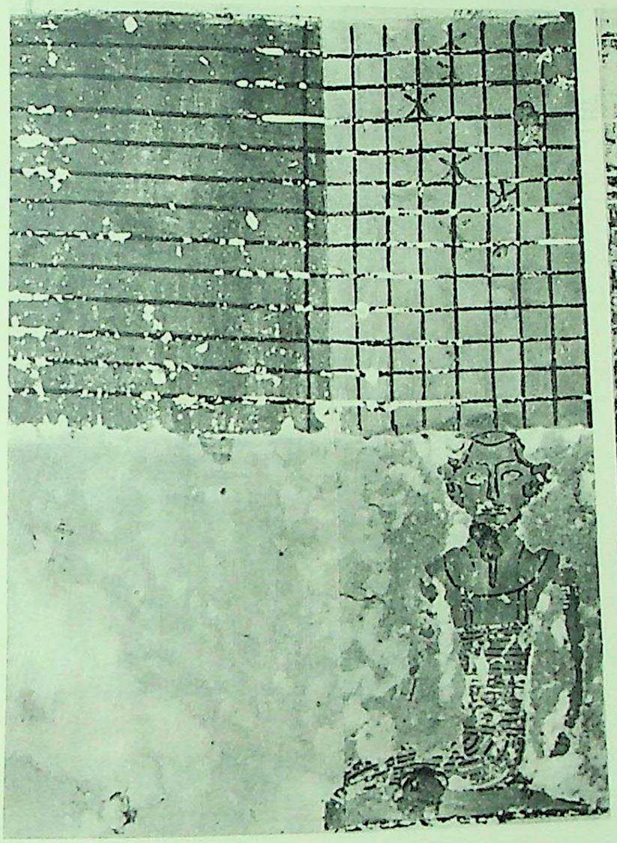
TABLE 1

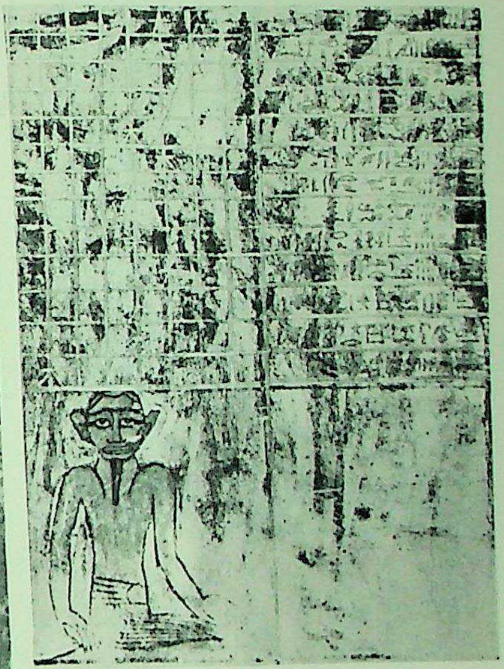


C
(b.)



D
(g.)



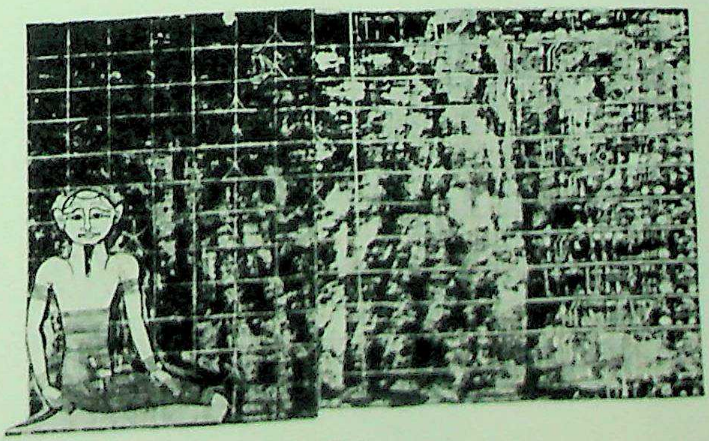


A

B
see Plate 3

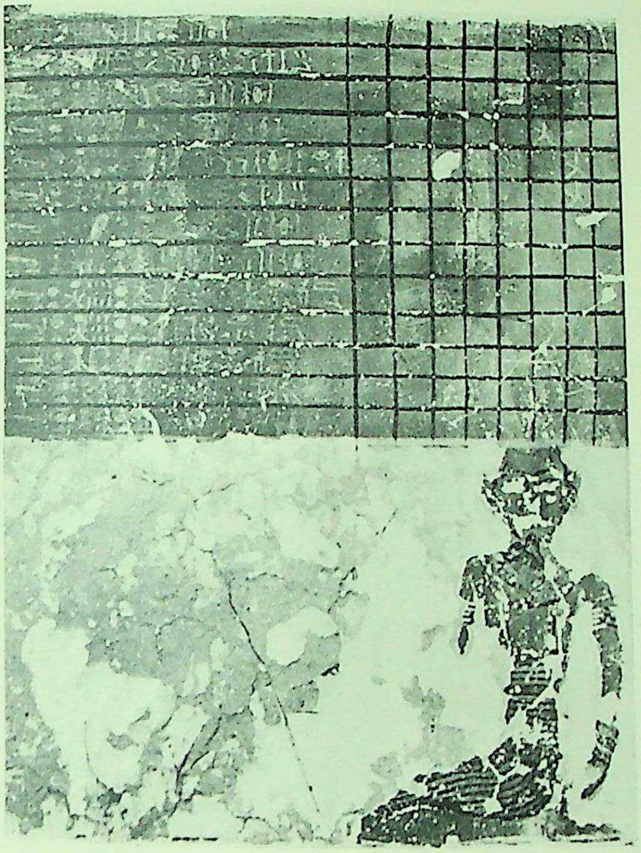
Text: (b.)

C

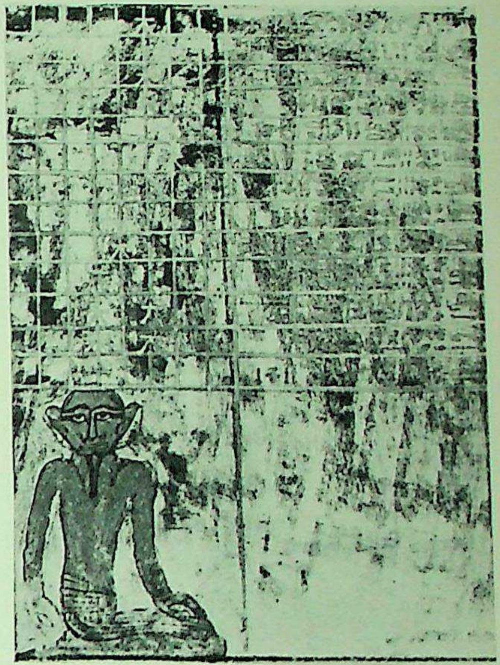


D (y.)

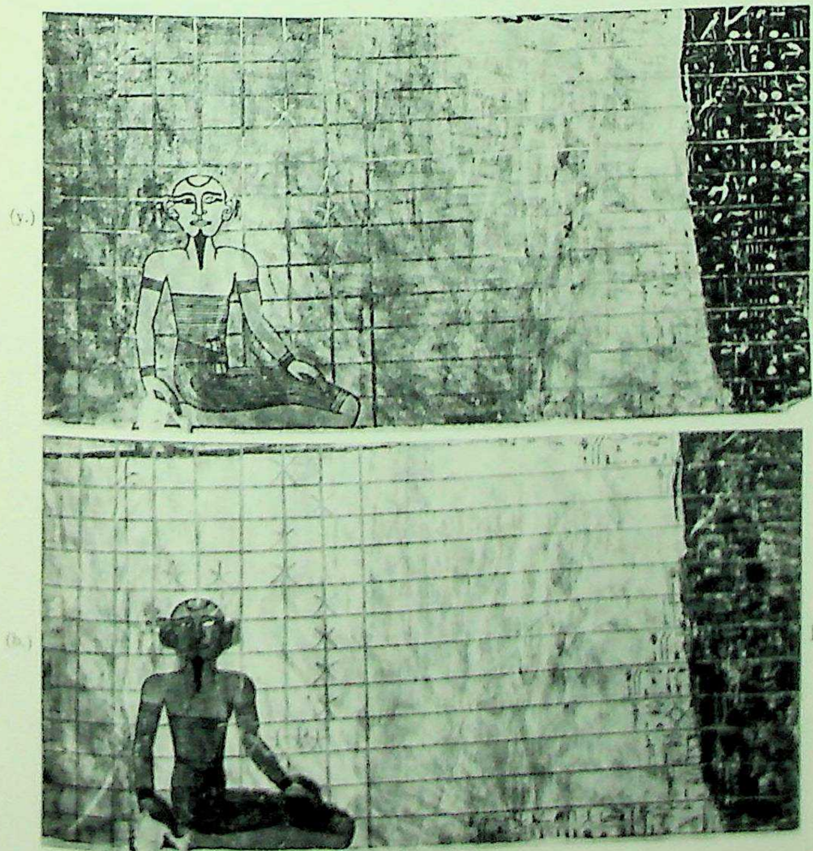
TABLE 2



C (b.)



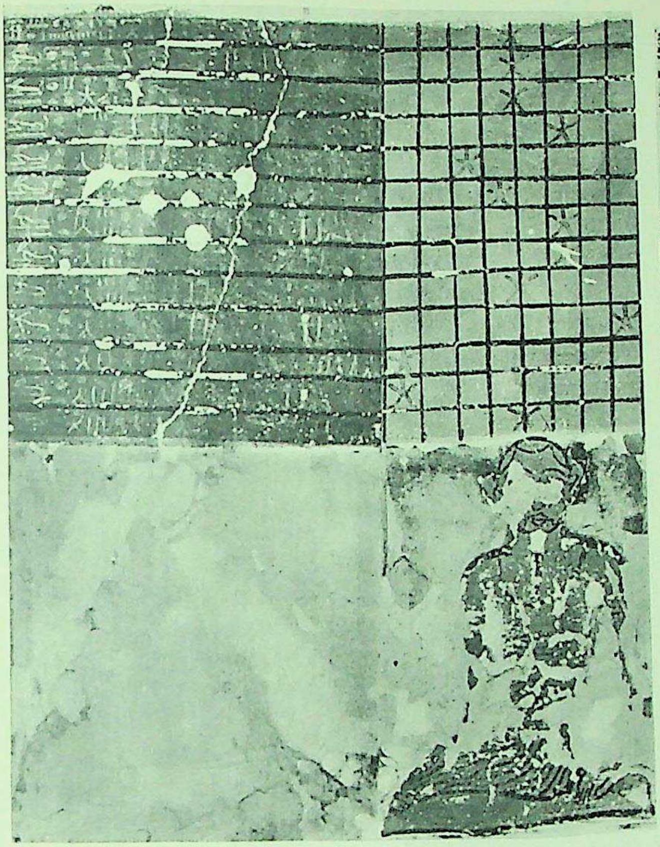
A



D

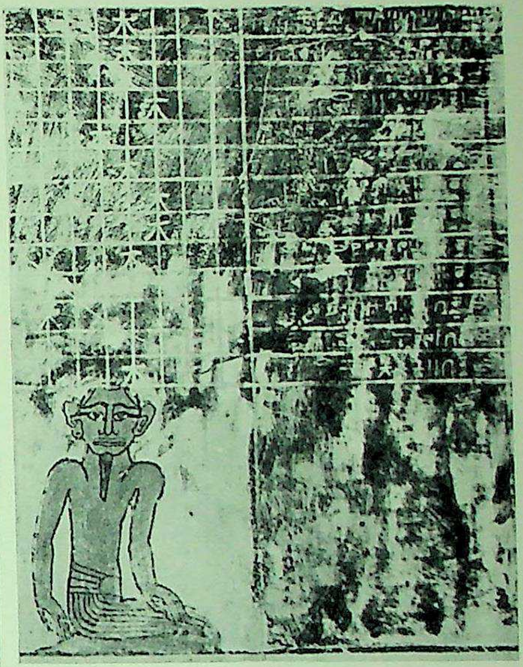
B

TABLE 3

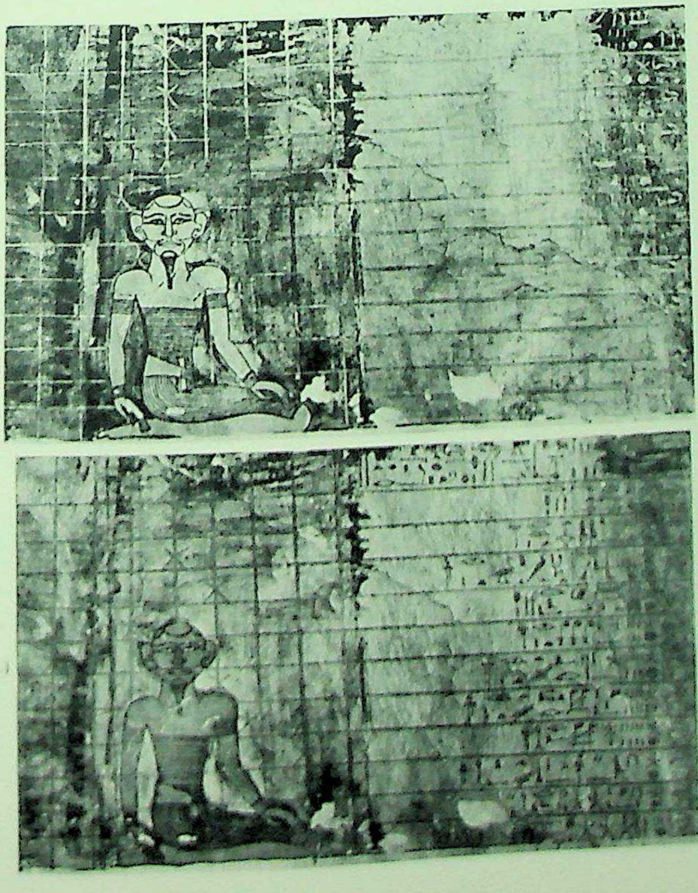


Text: (b.)

C



A



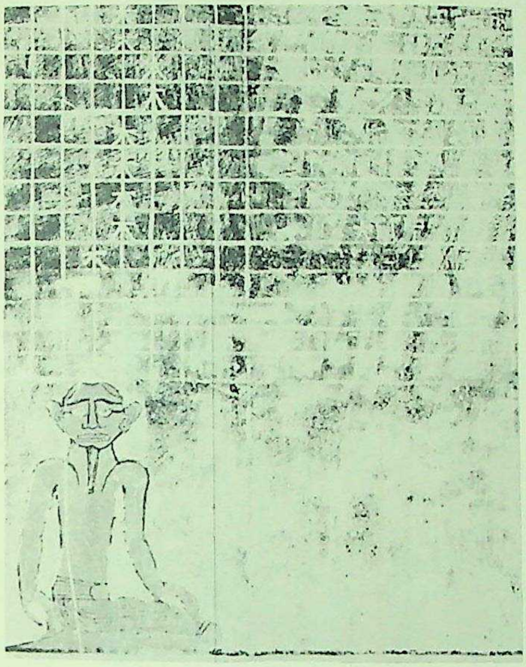
(y.)

(b.)

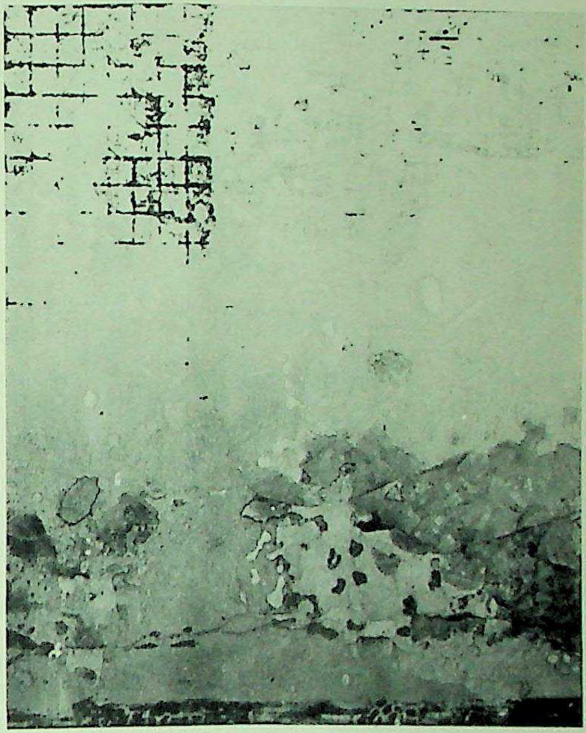
D

B

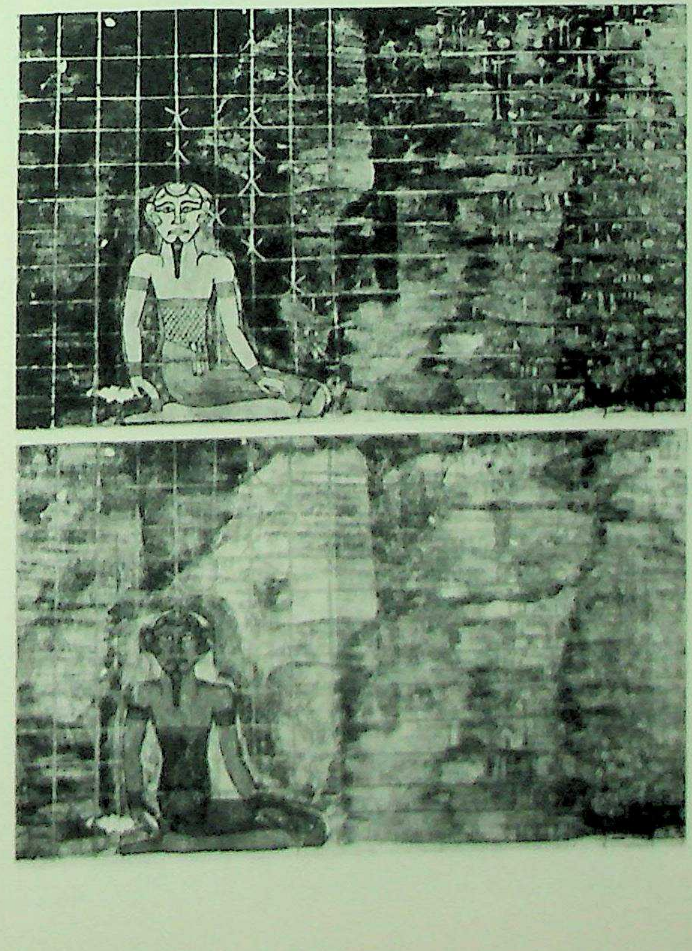
TABLE 4



A



B

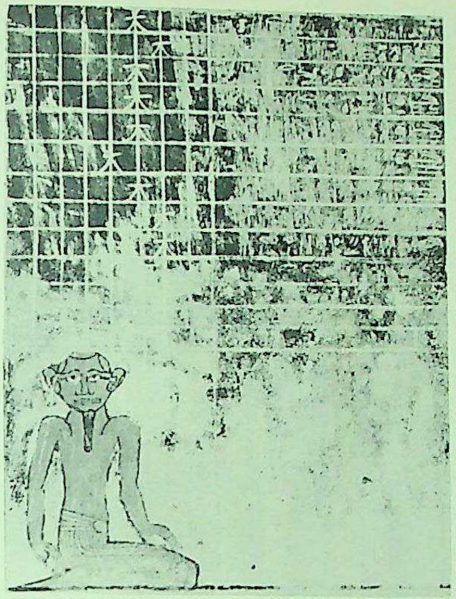


(a)

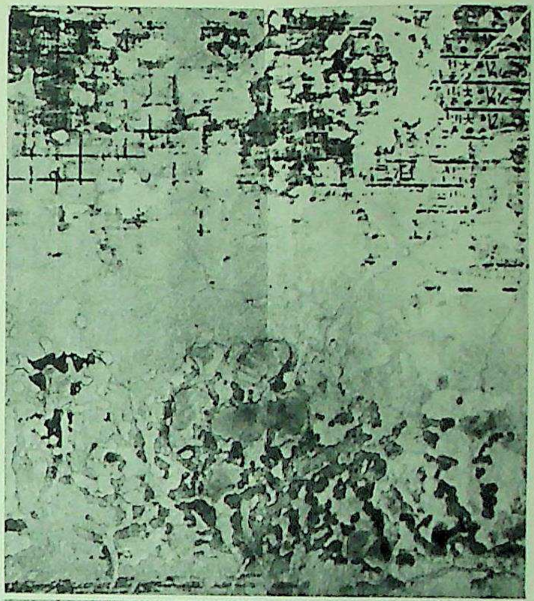
D

(b)

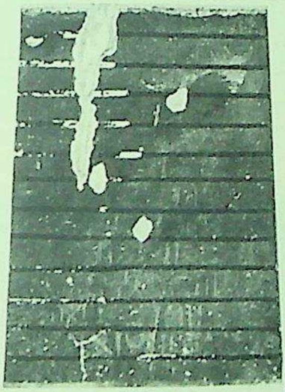
TABLE 5



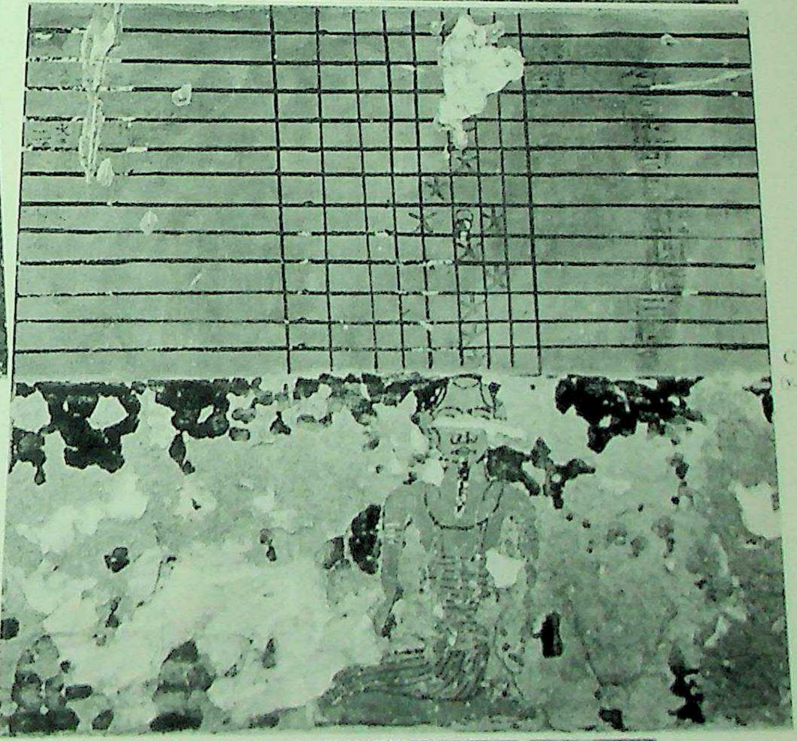
A



B

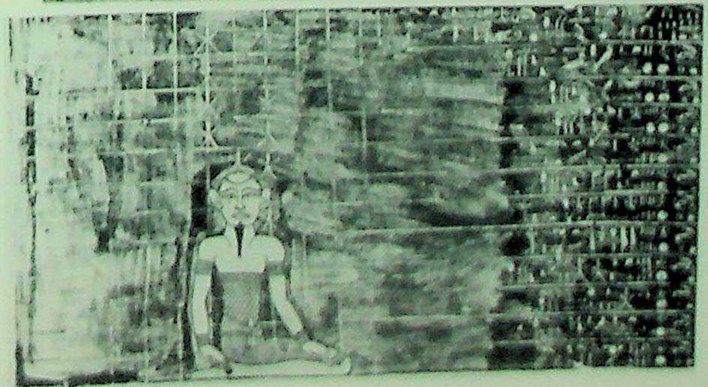


C (b.)

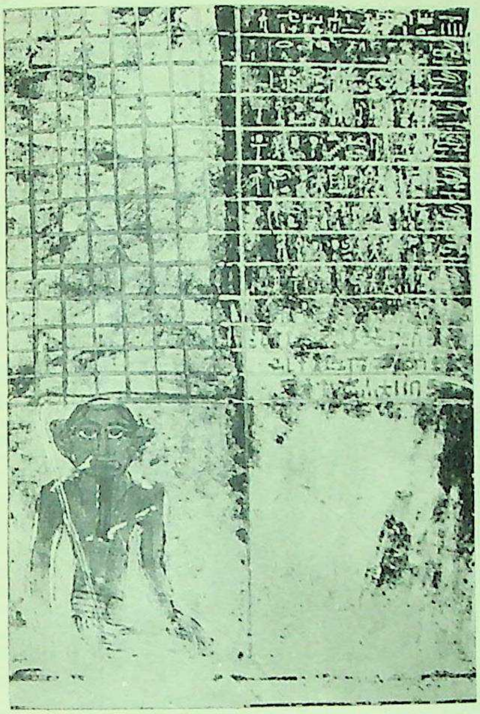


C (a.)

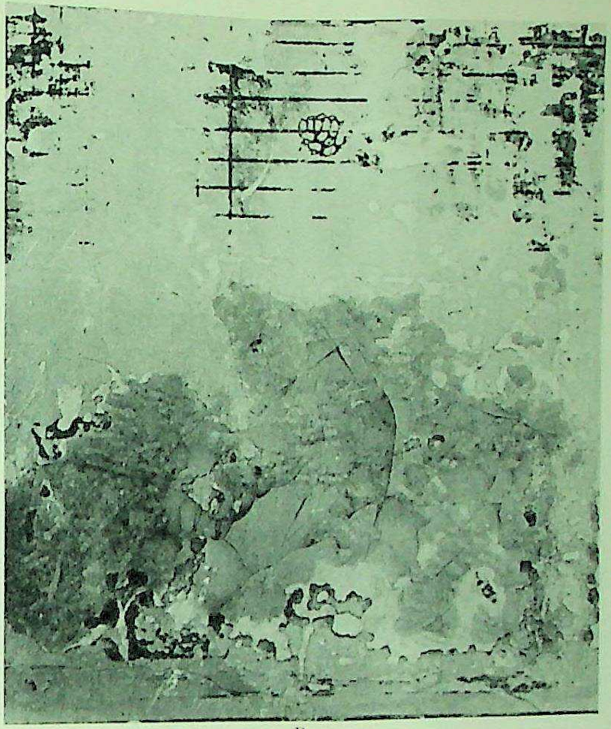
TABLE 6



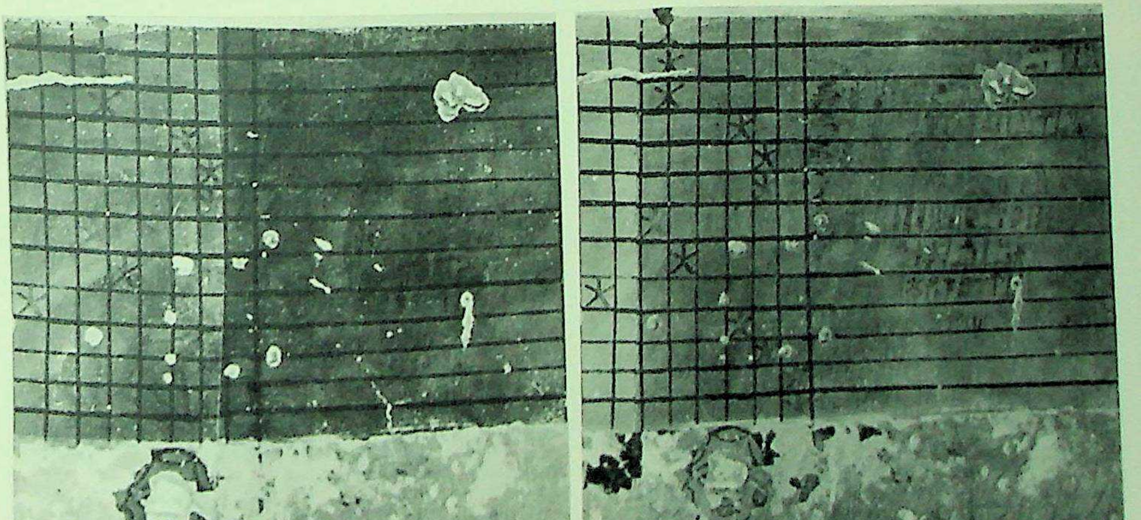
D (a.)



A



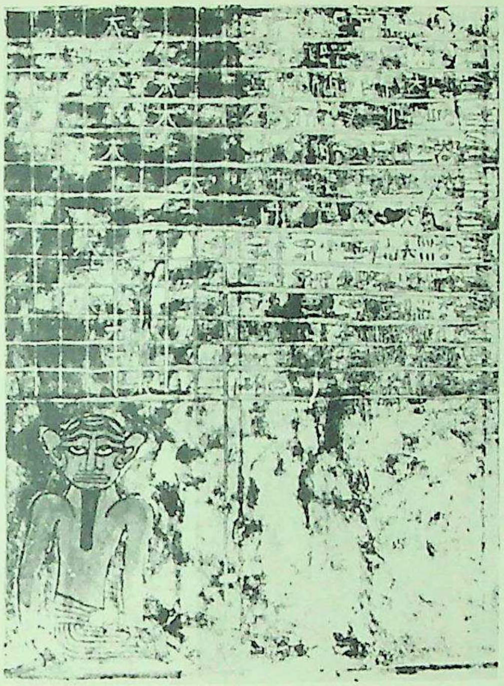
B



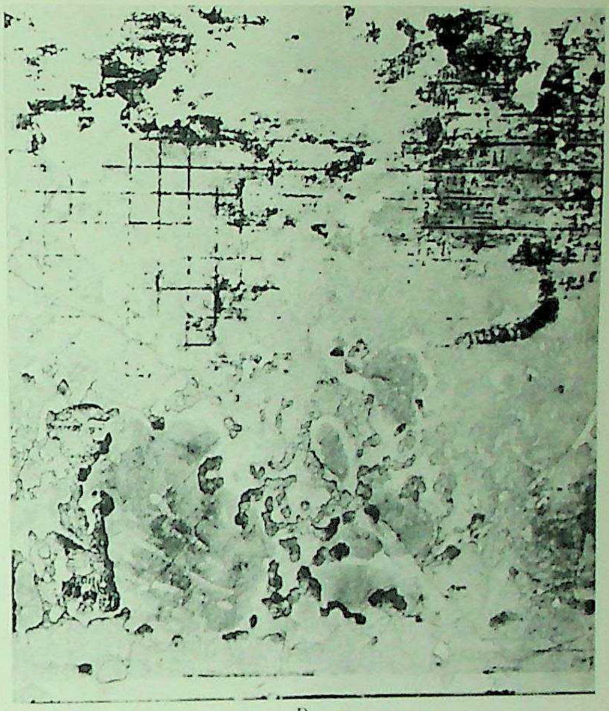
(b) C (a)

TABLE 7

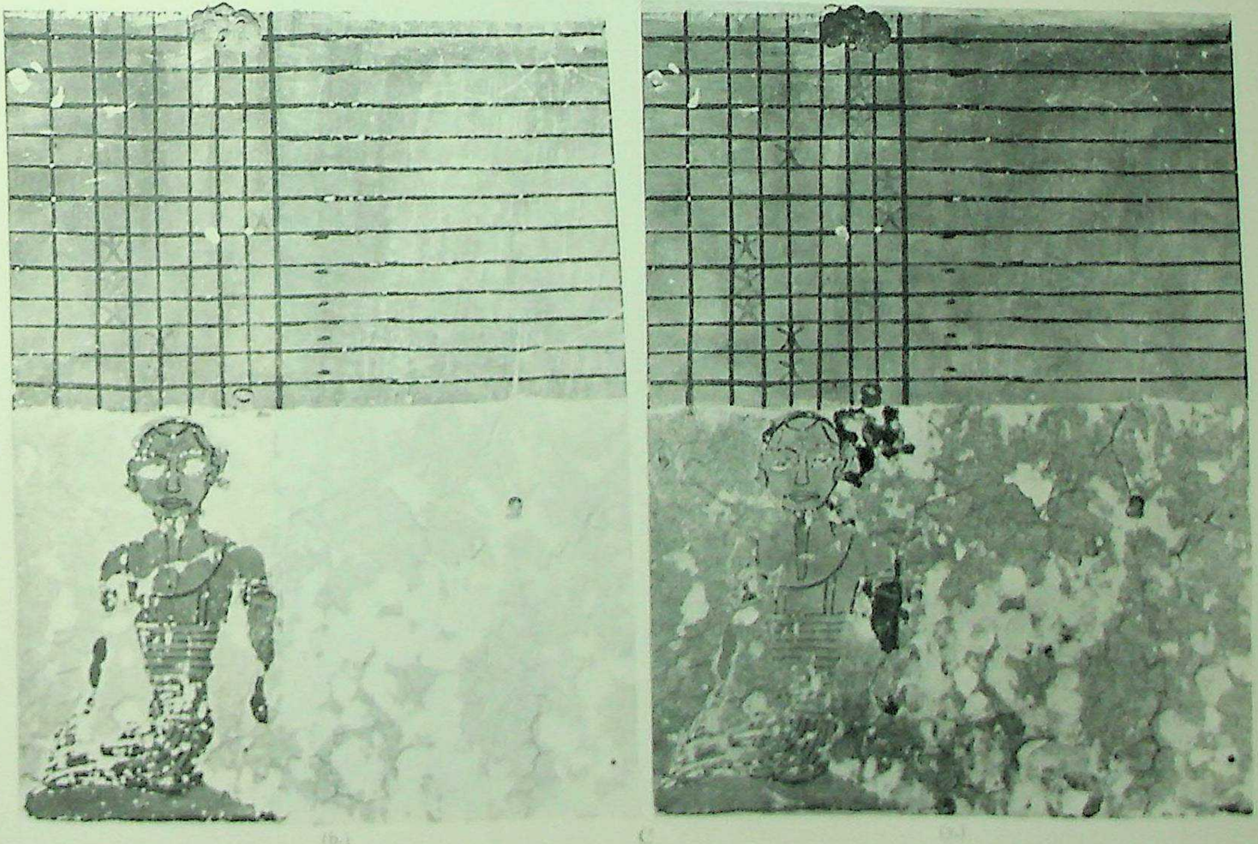
PLATE 16



A



B



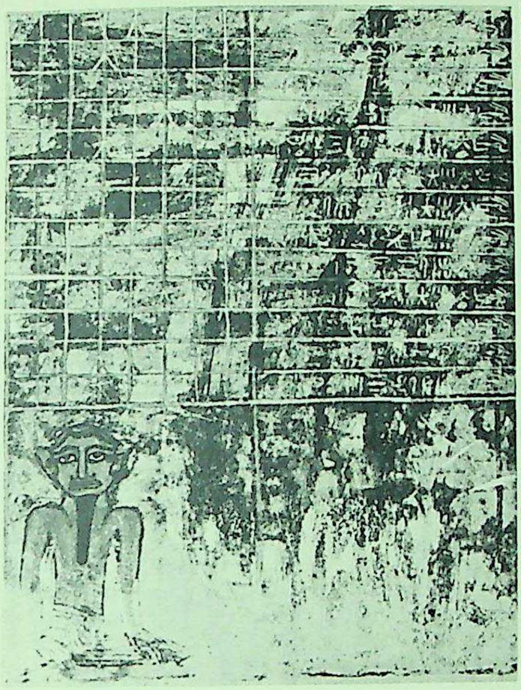
(b)

C

(a)

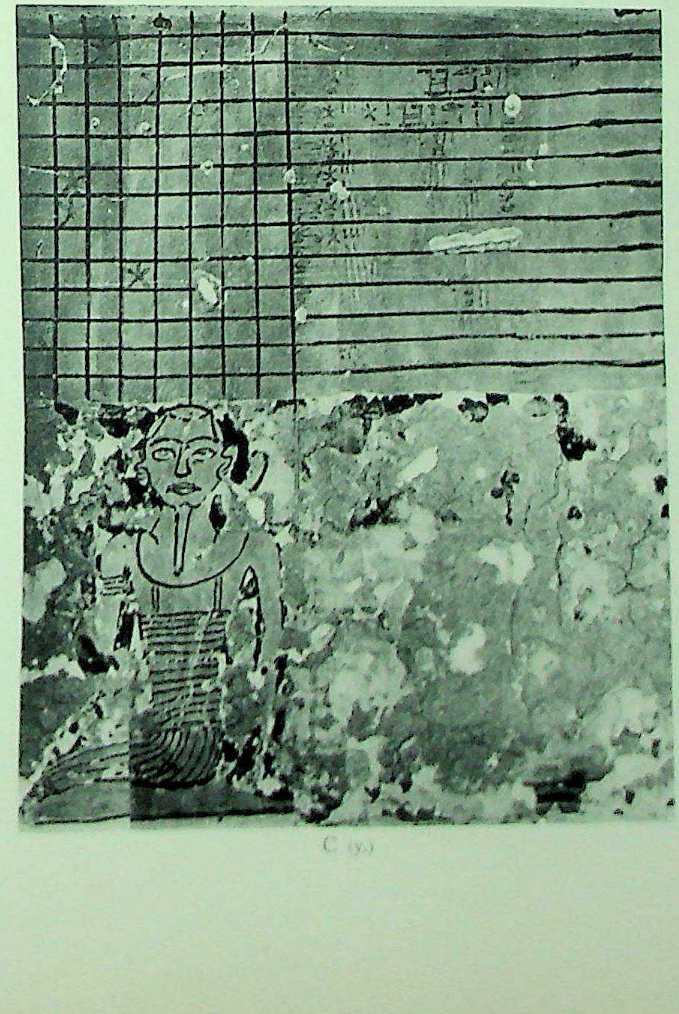
TABLE 8

PLATE 17



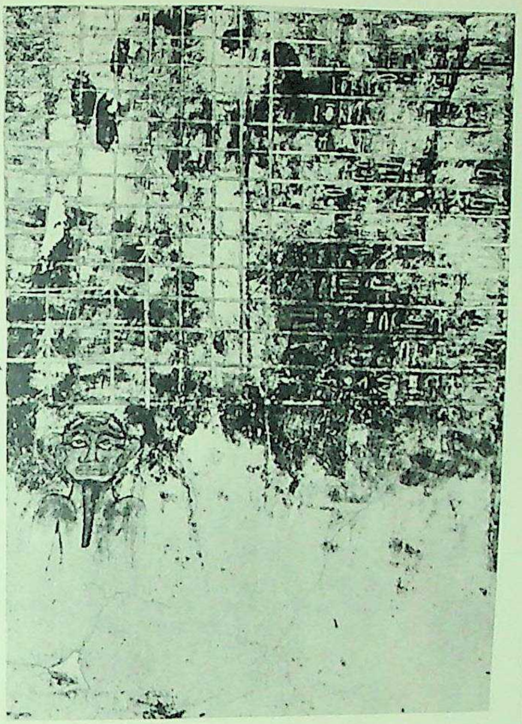
A

B

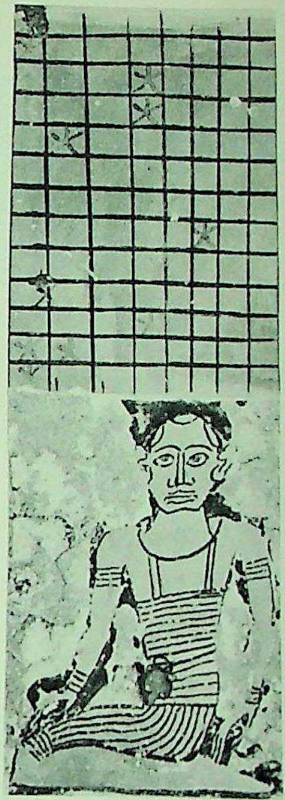


C (y.)

TABLE 9

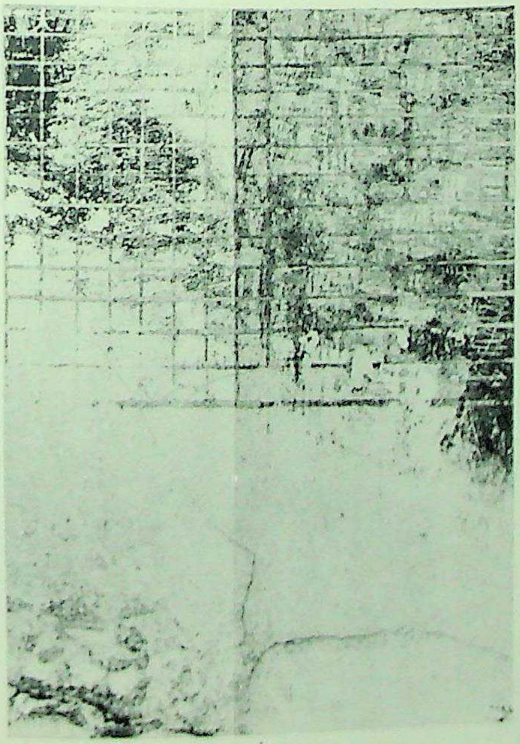


A

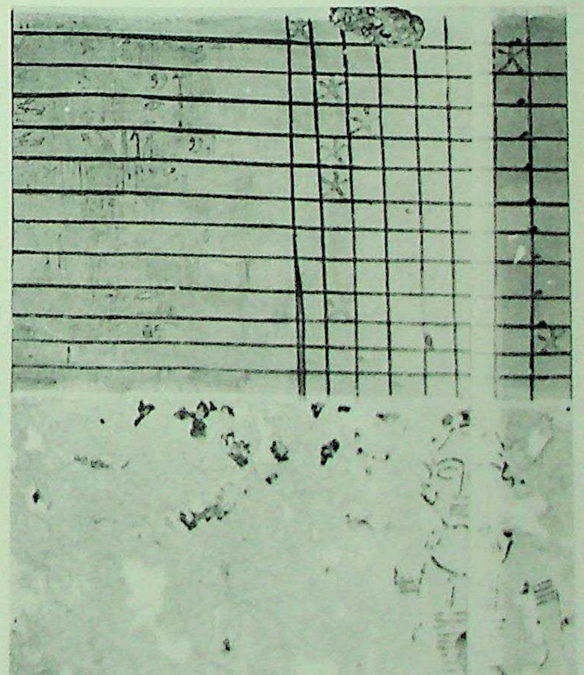


C
(y.)

TABLE 10



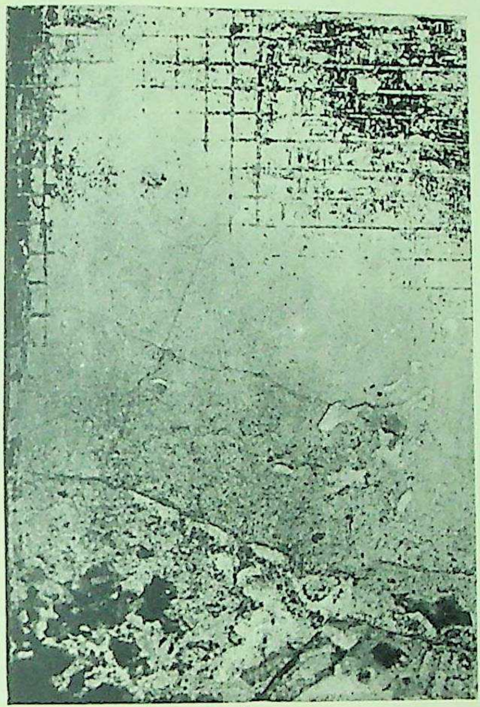
A



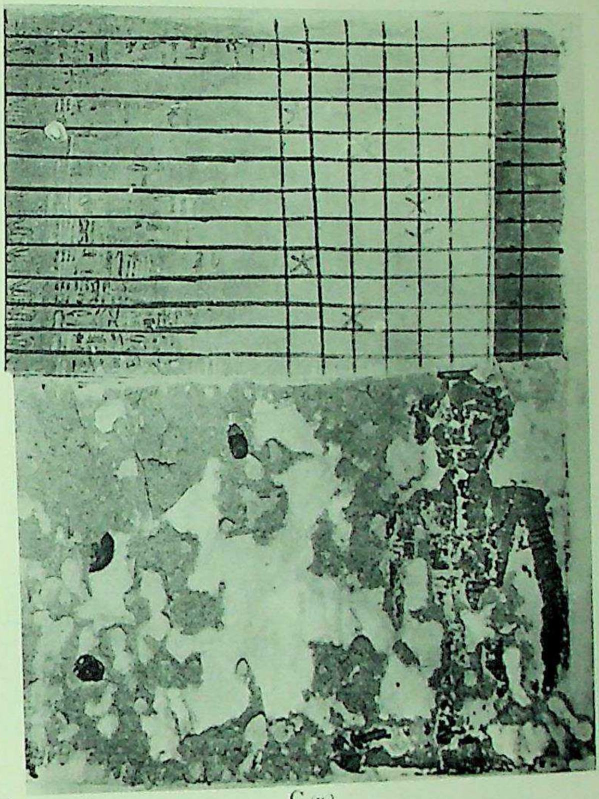
C (y.)

TABLE 11

PLATE 19

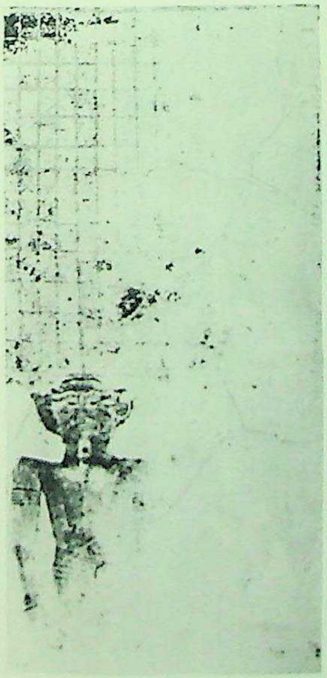


A

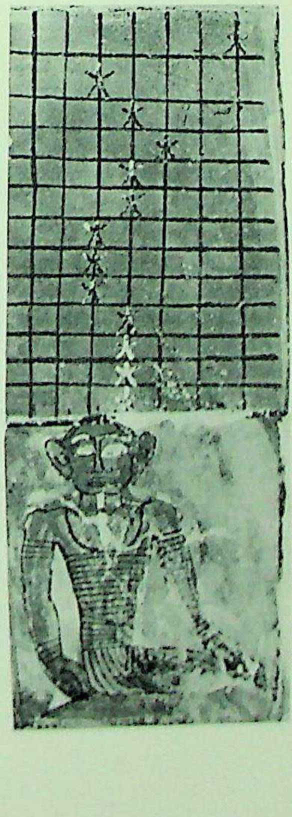


C (y.)

TABLE 12

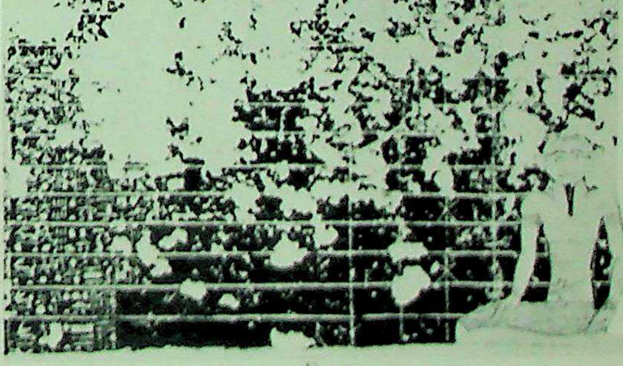


A

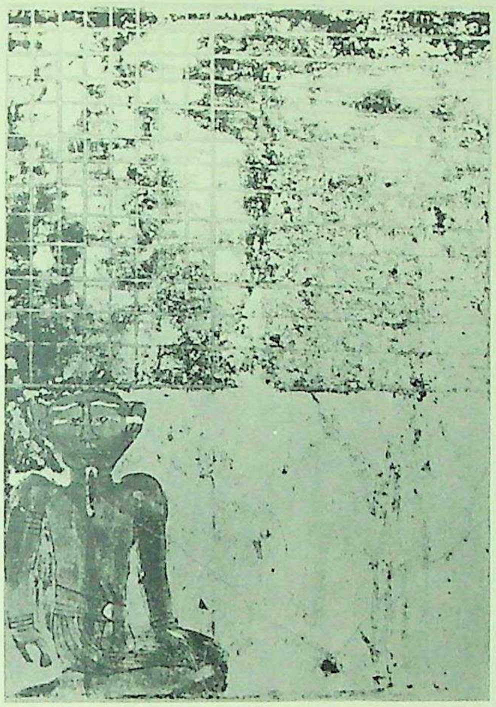


C (y.)

TABLE 13

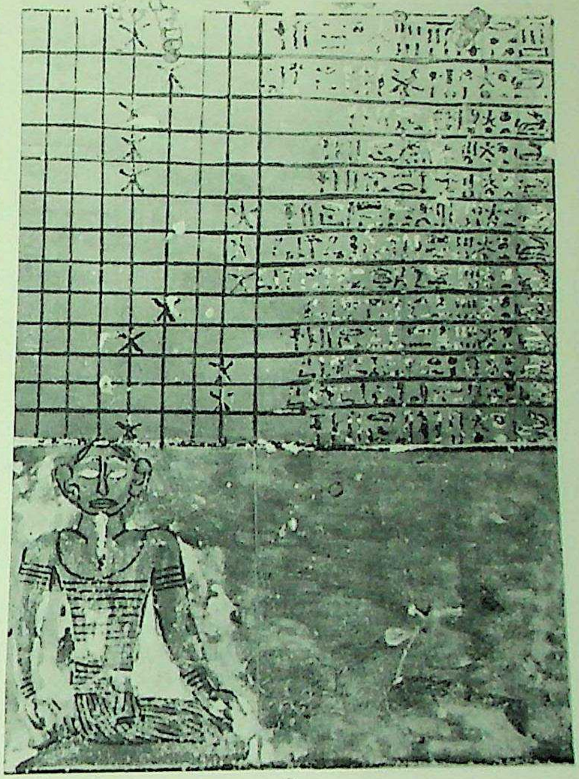


D (y.)

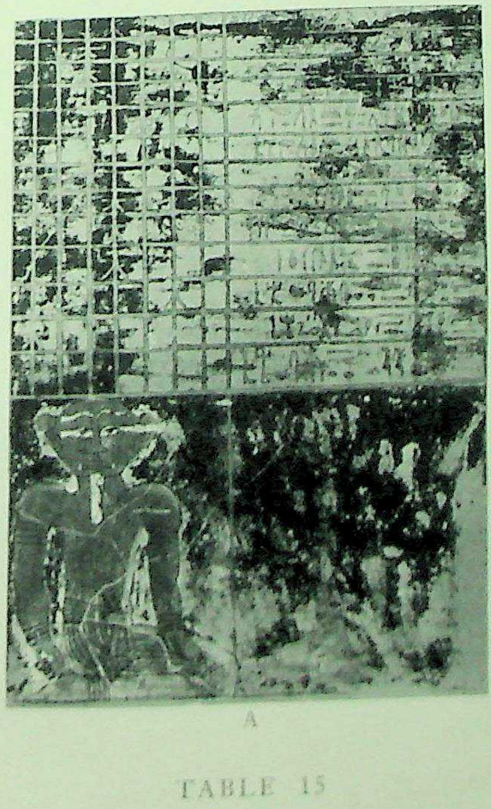


A

TABLE 14

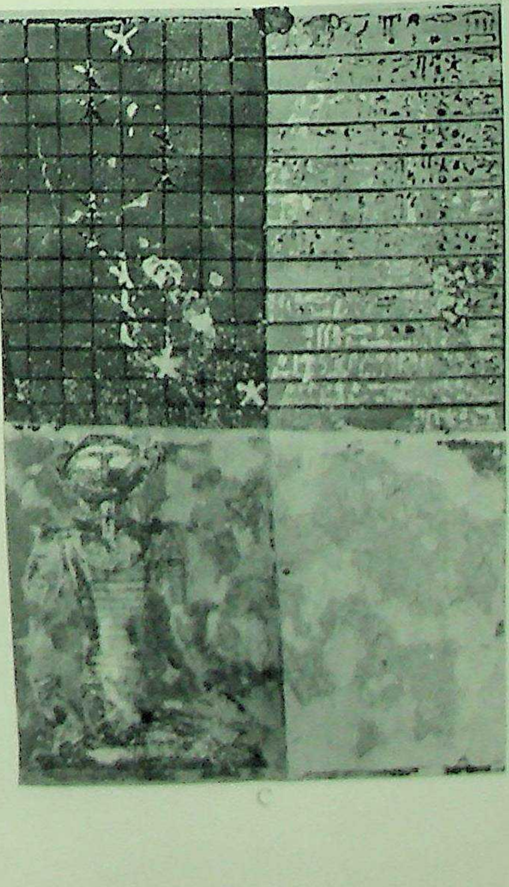


C

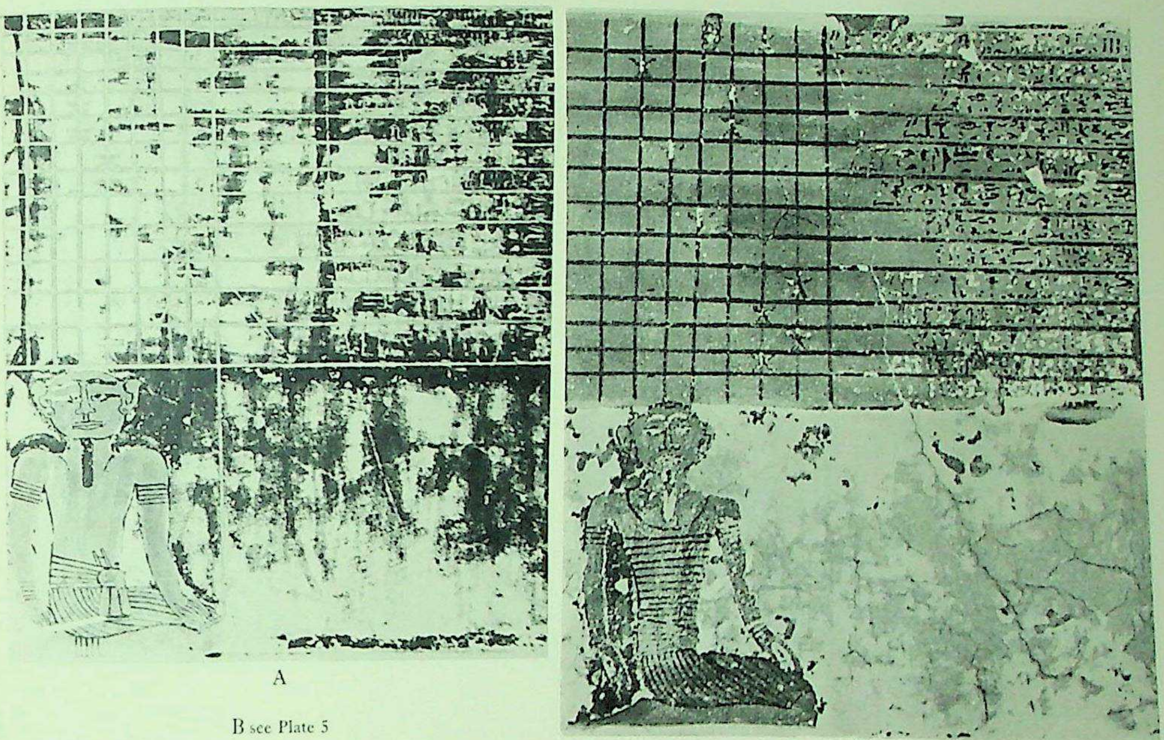


A

TABLE 15



C

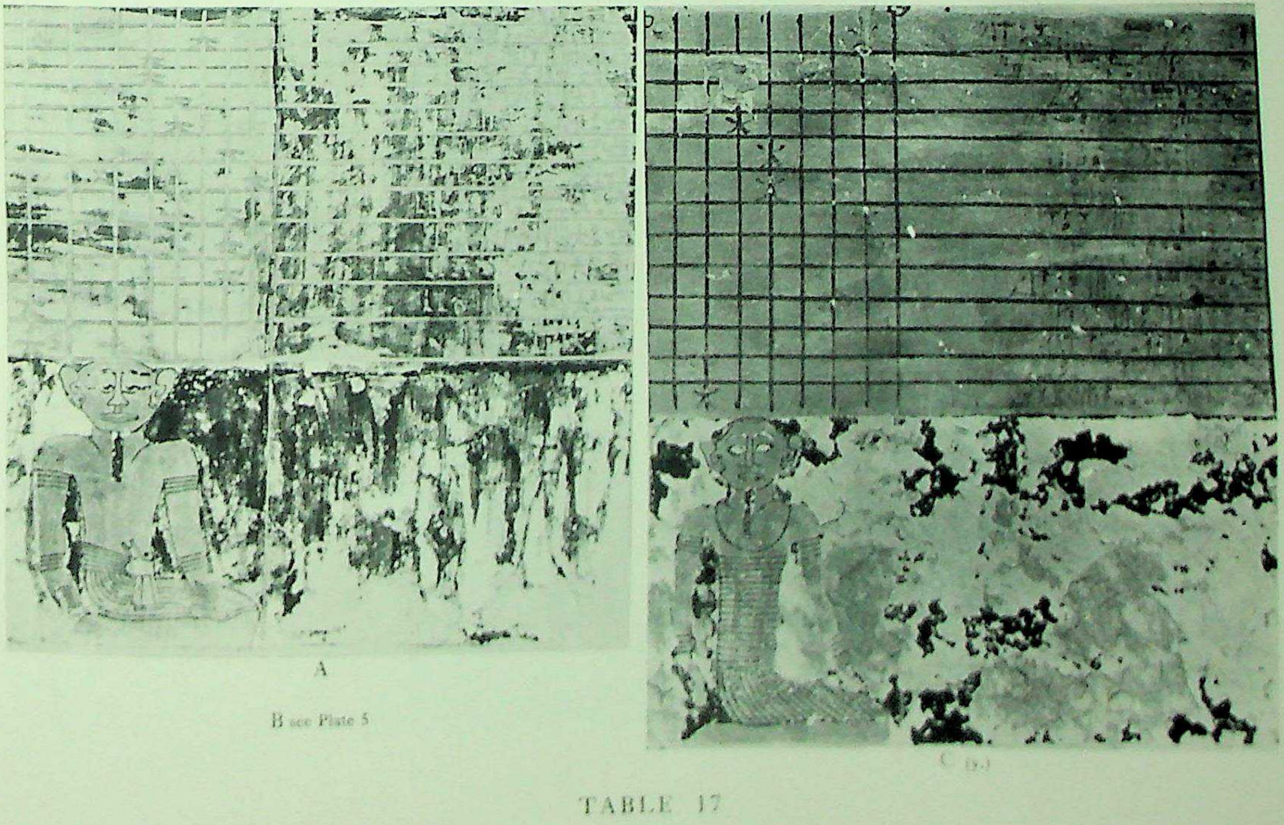


A

B see Plate 5

C

TABLE 16

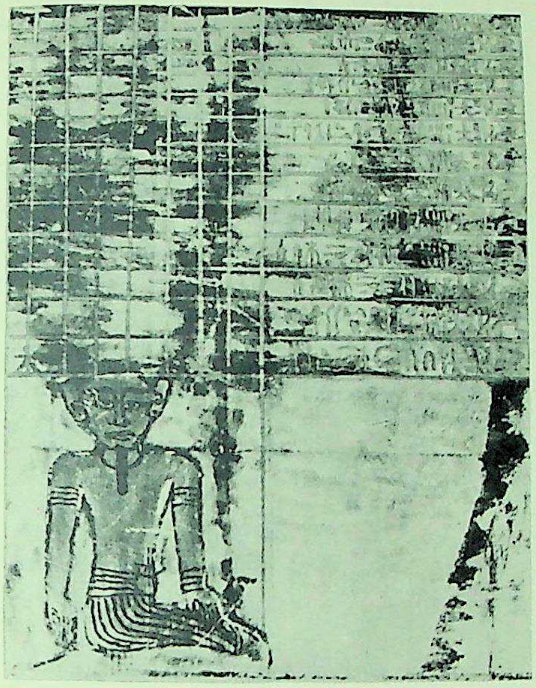


A

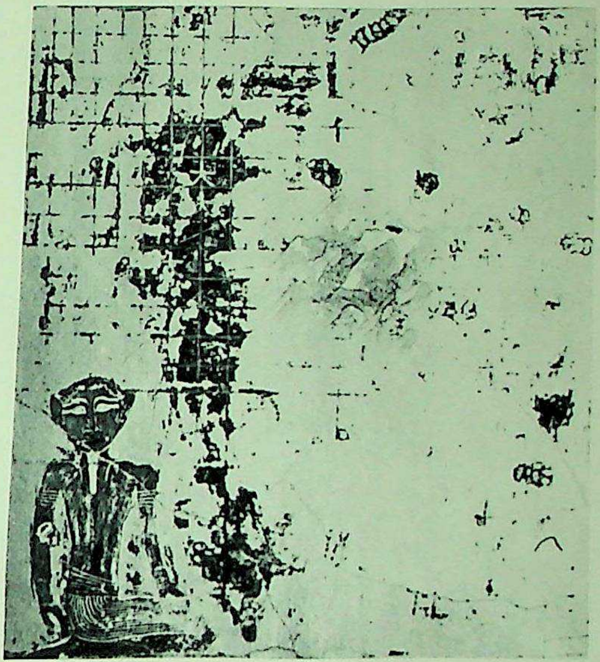
B see Plate 5

C (p.)

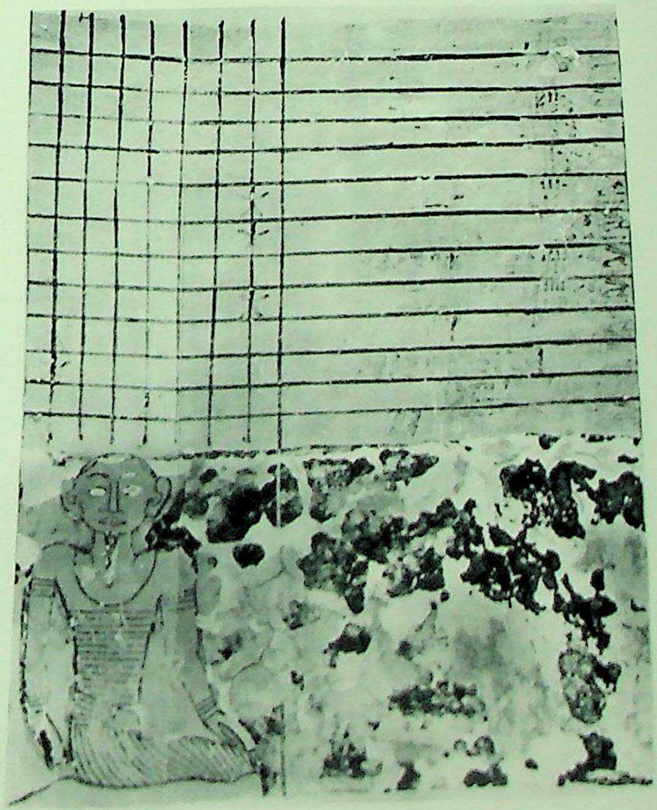
TABLE 17



A



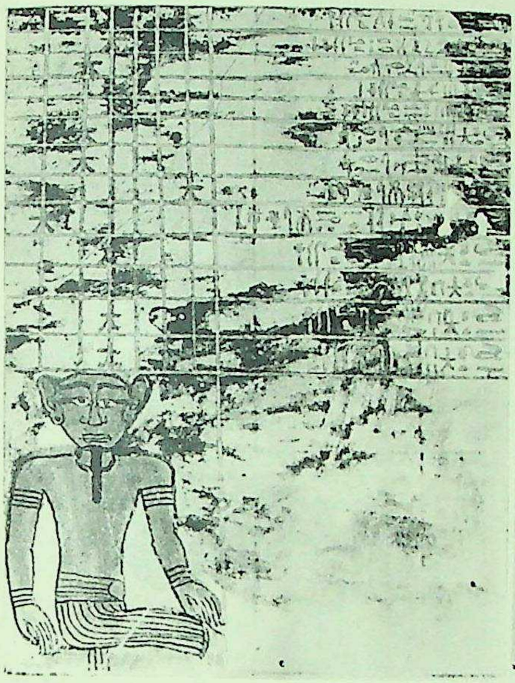
B

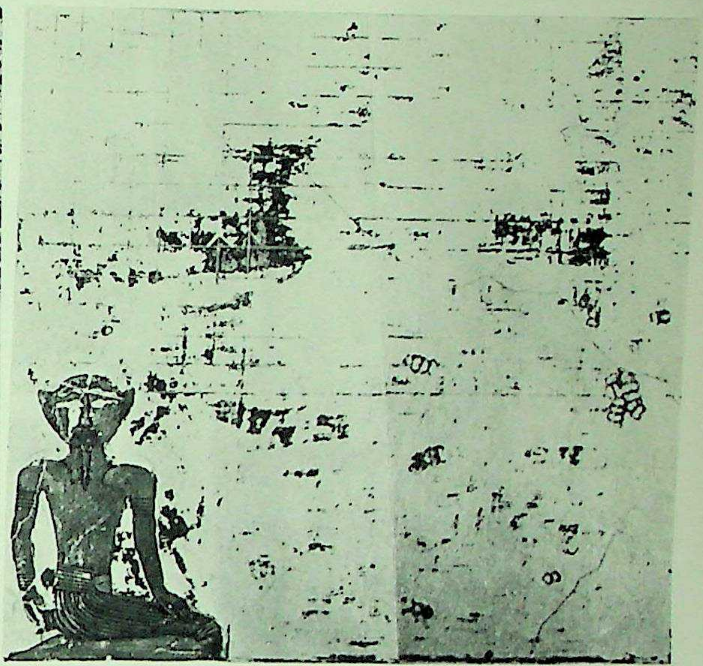


C (y)

TABLE 18

PLATE 23


A


B

C (b)

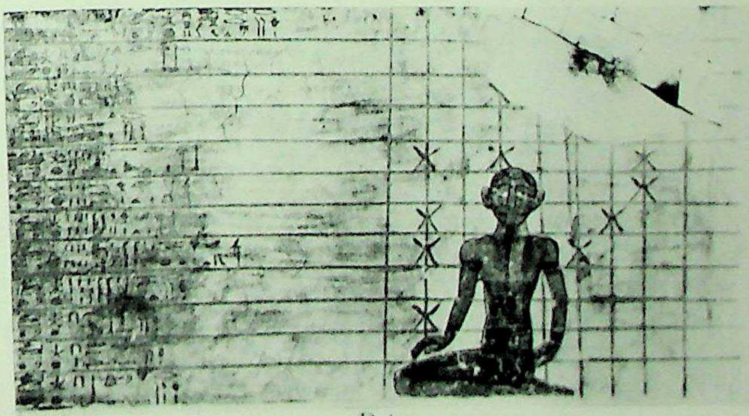
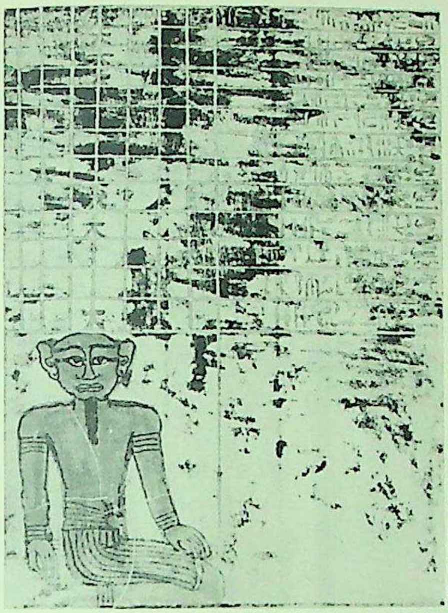
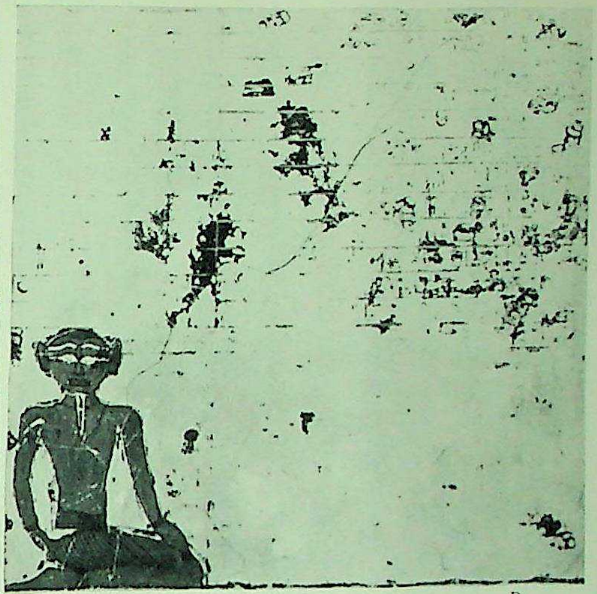

D (b.)

TABLE 19

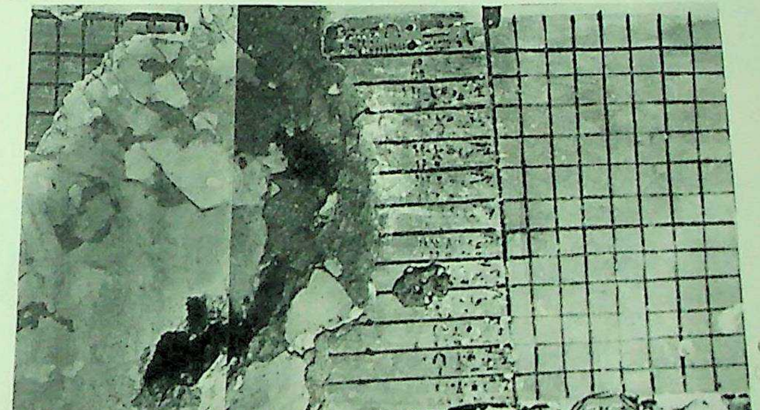


A



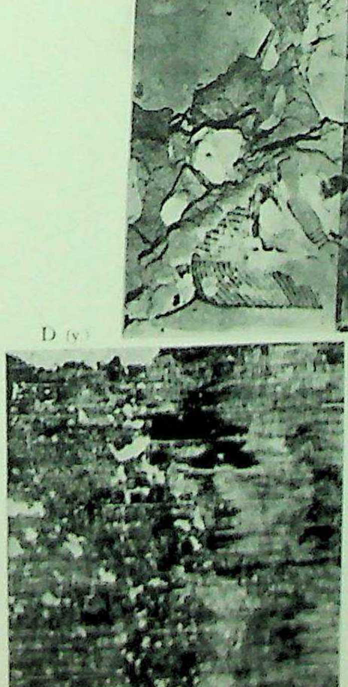
B

TABLE 20

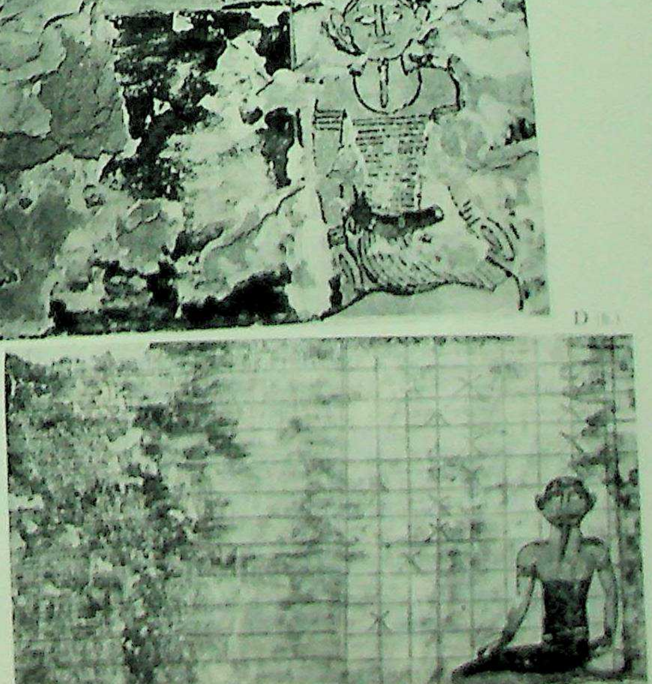


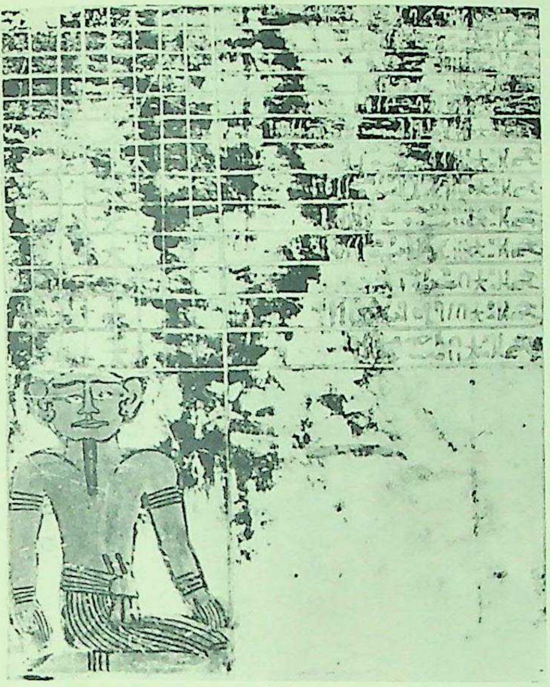
C (y.)

D (y.)

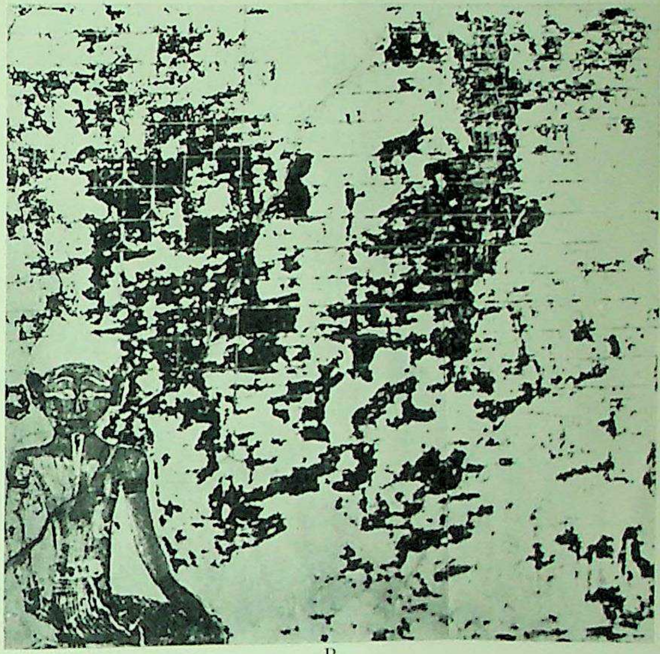


D (b.)

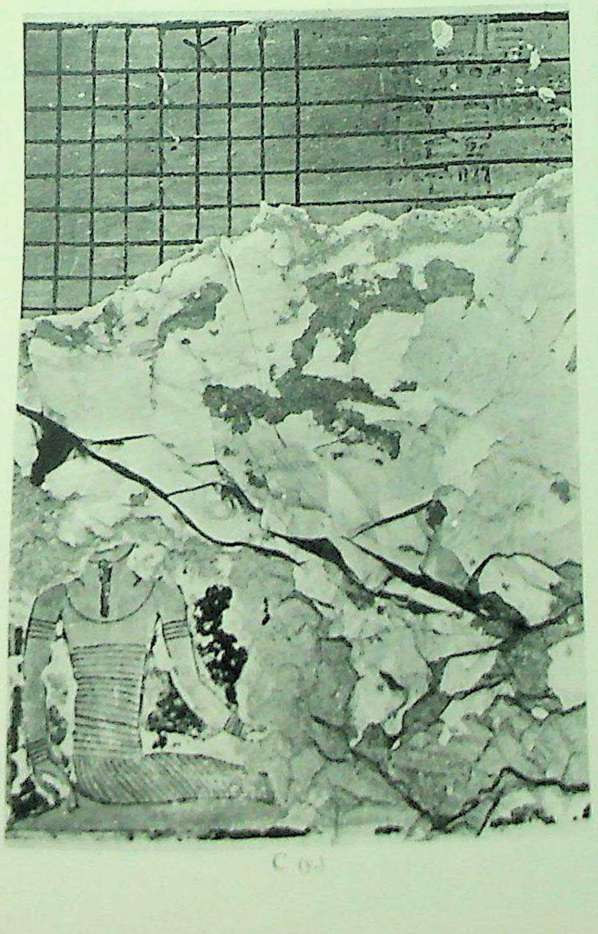




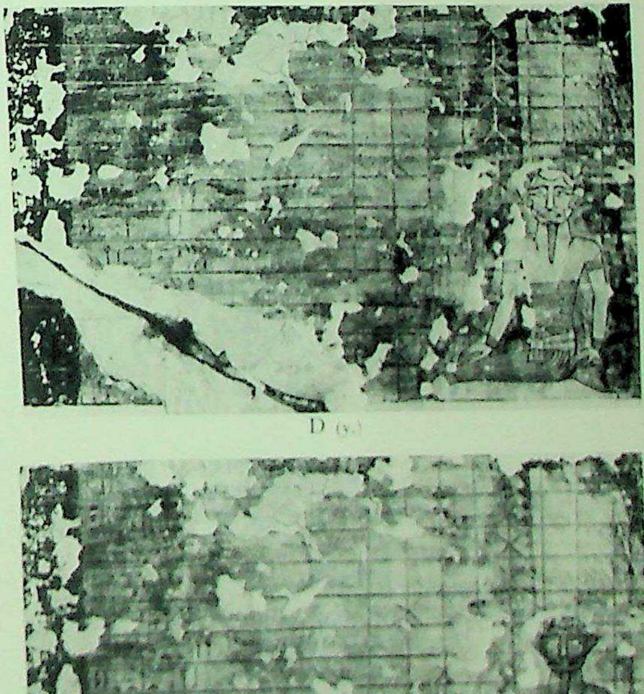
A



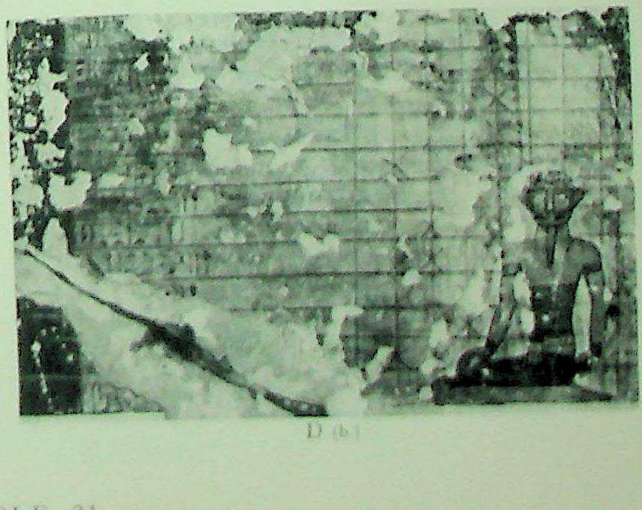
B



C (b)



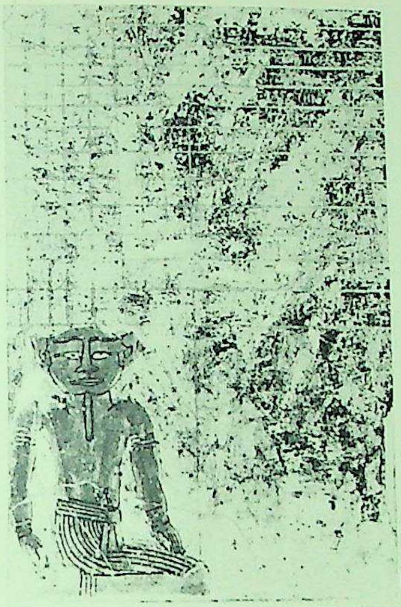
D (a)



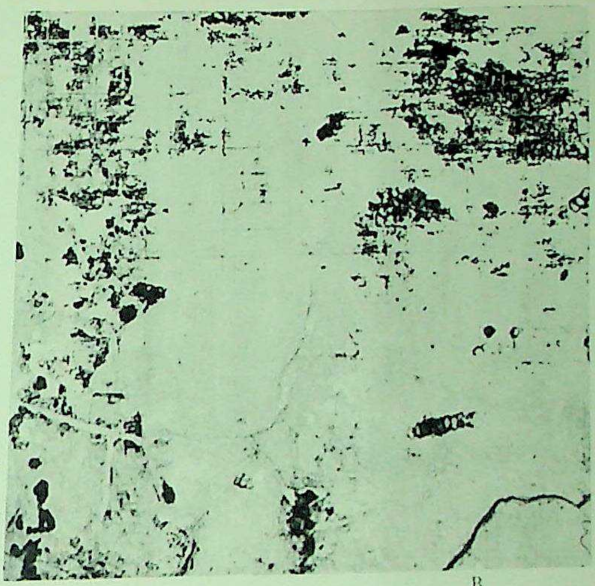
D (b)

TABLE 21

PLATE 26

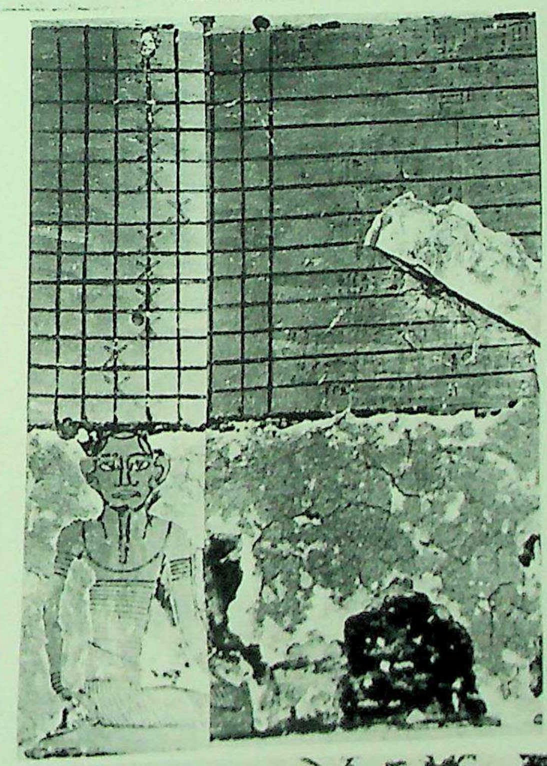


A



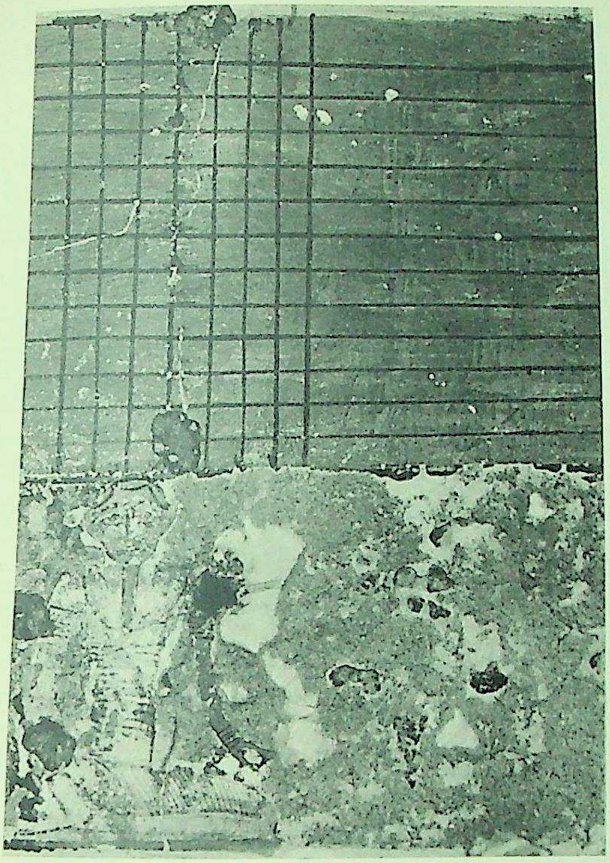
B

TABLE 22

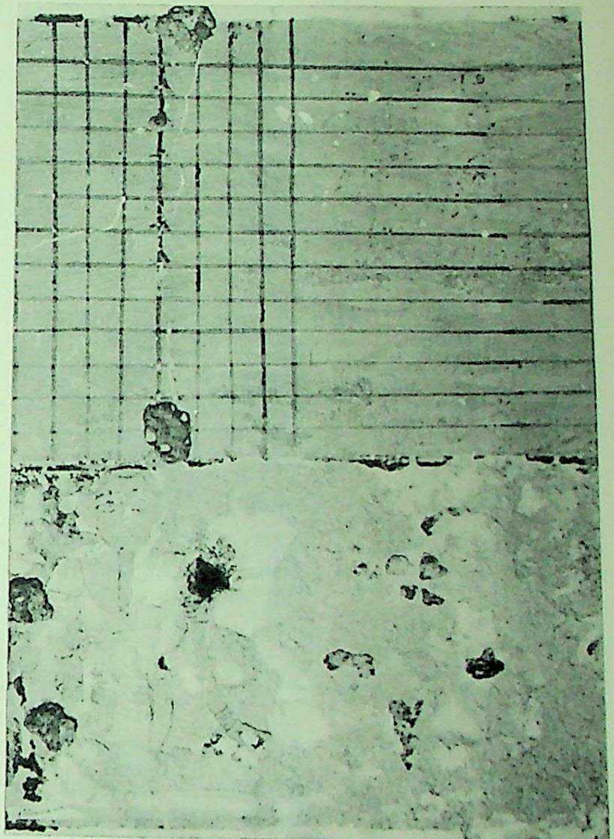


C (?)

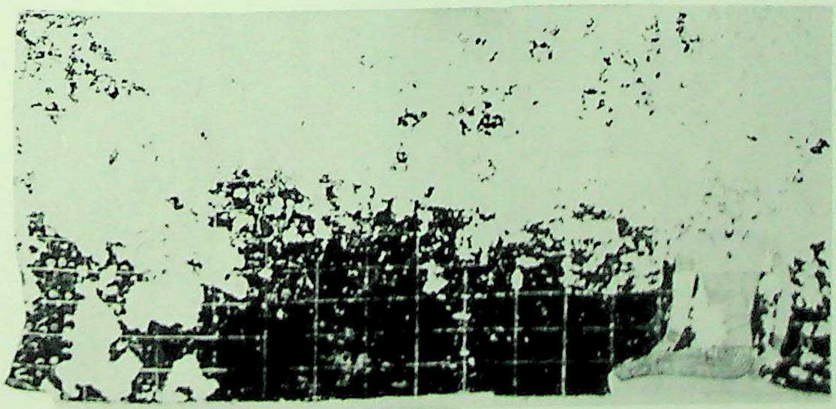
D (?)



C (y.)



C (r.)

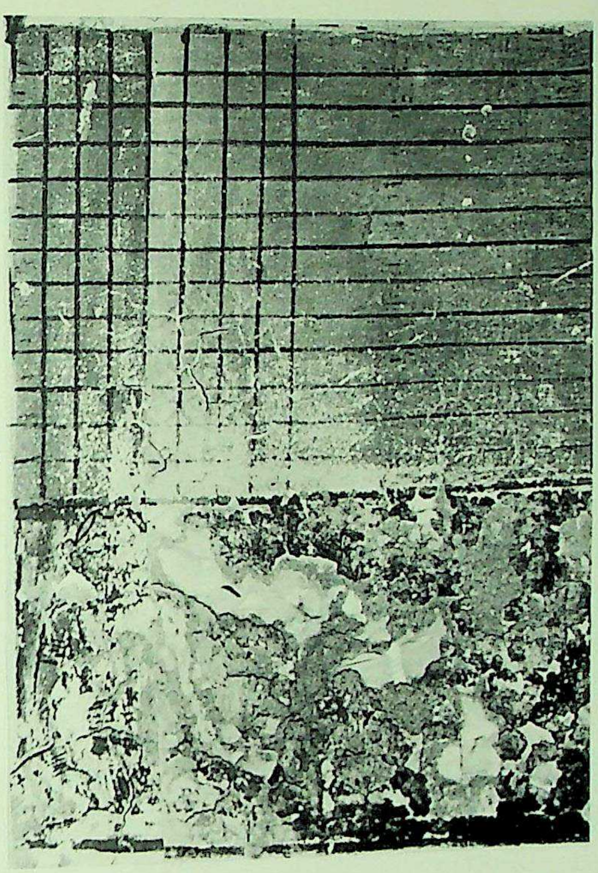


D (y.)

A

TABLE 23

C
(y.)



C
(r.)

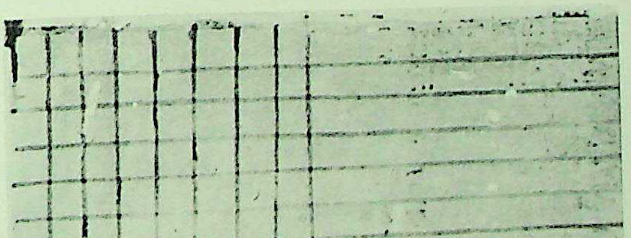


TABLE 24

TABLE 1

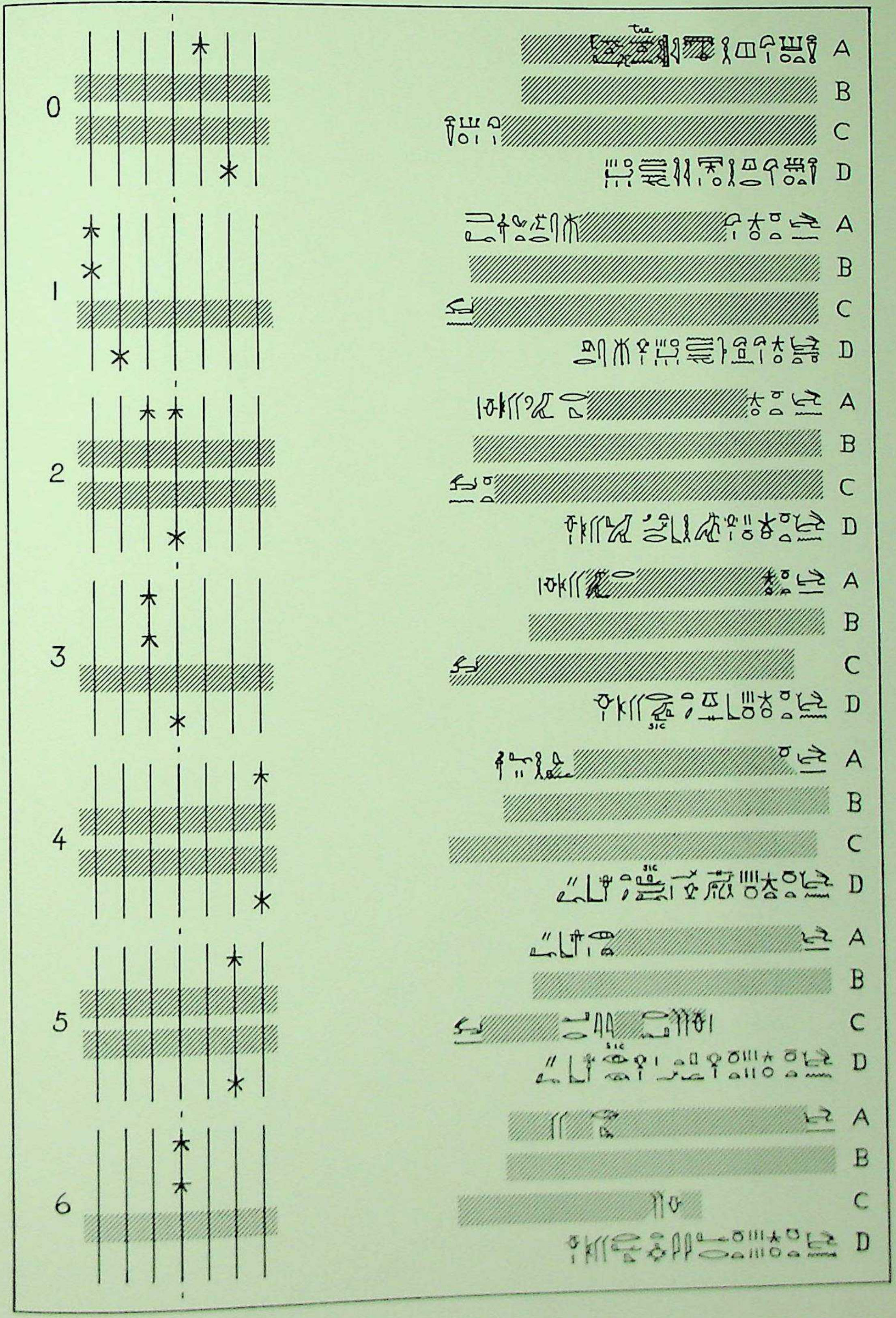

0
1
2
3
4
5
6
A
B
C
D
sic

TABLE 1

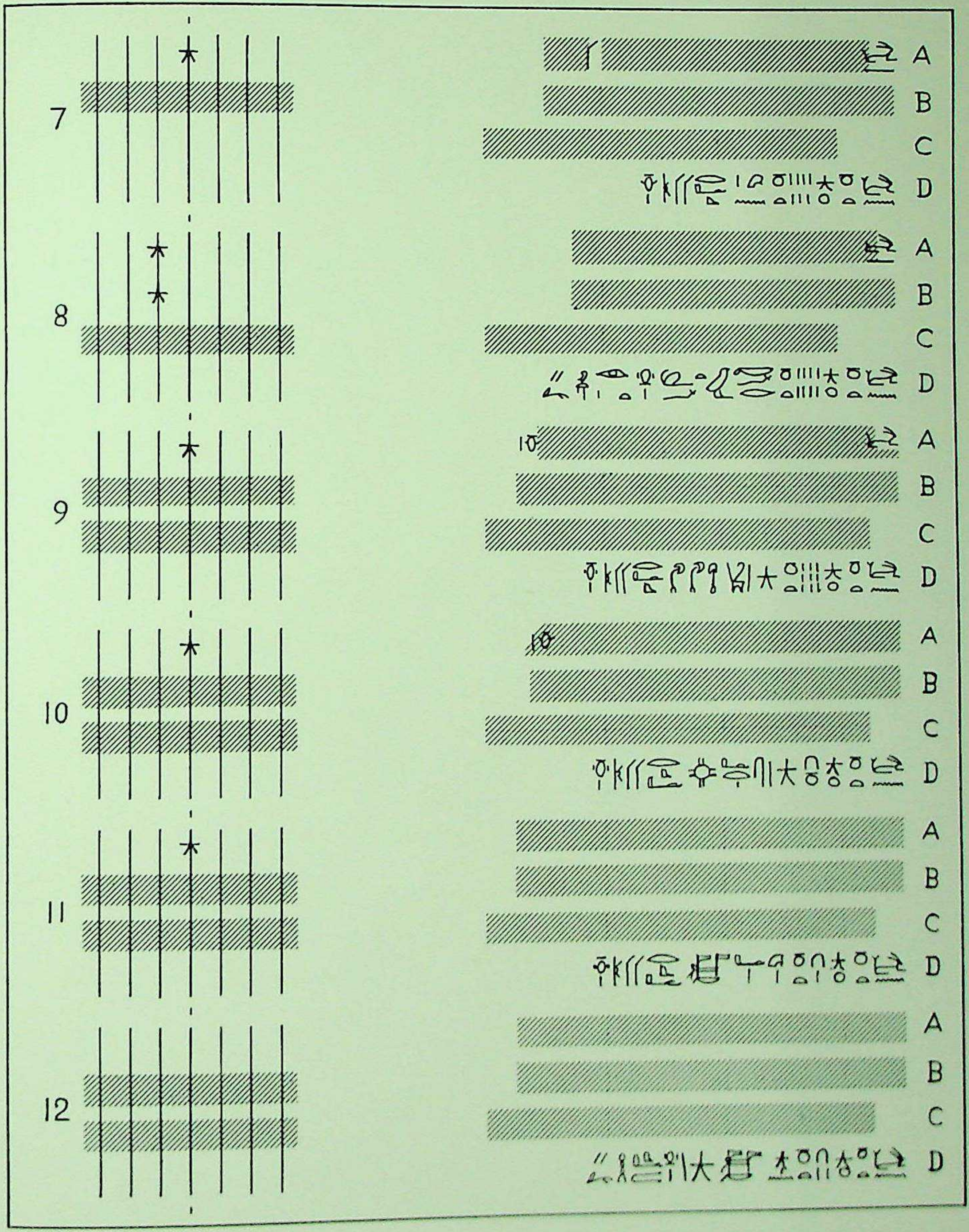

7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D
11
A
B
C
D
12
A
B
C
D

TABLE 2

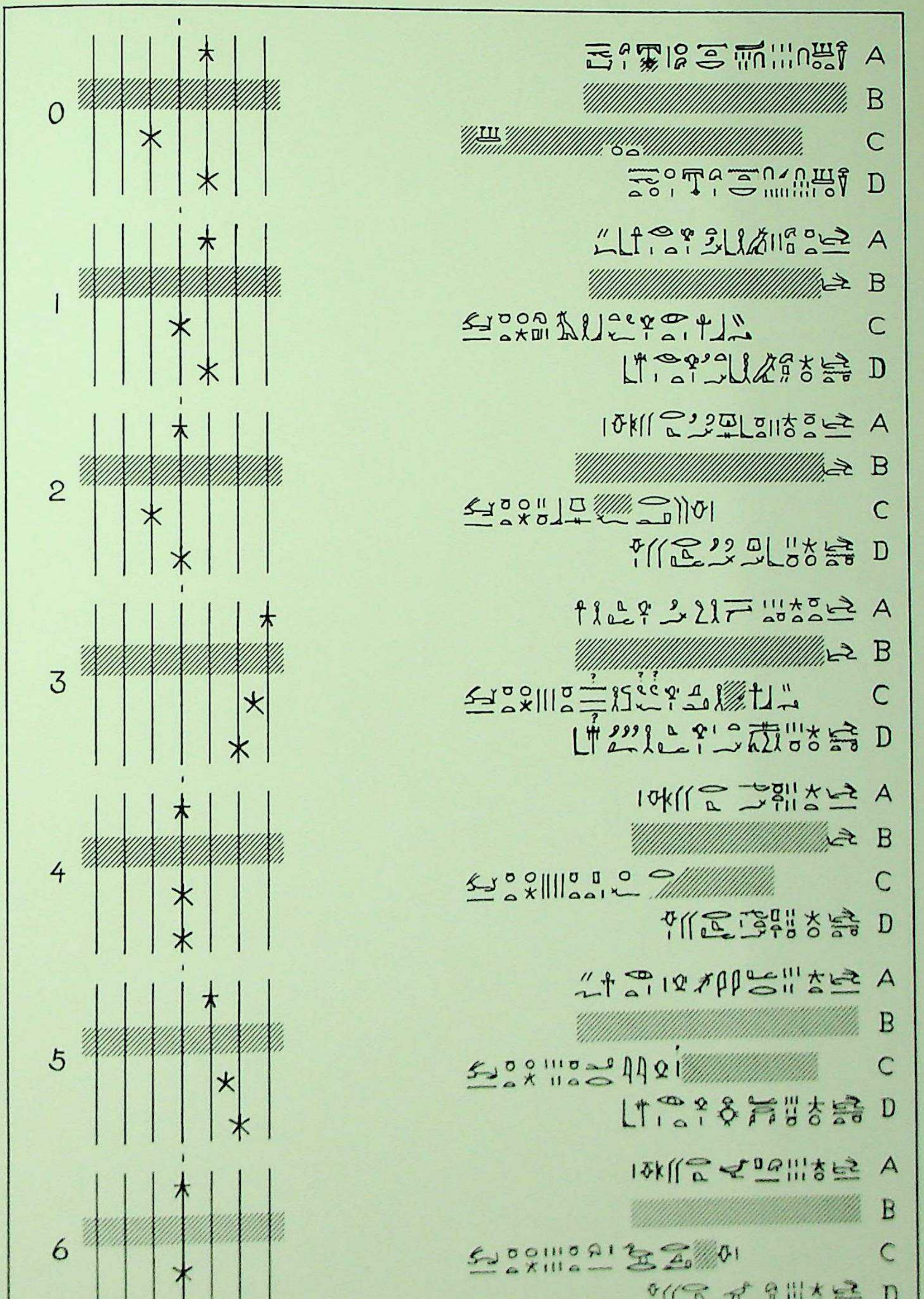

0
1
2
3
4
5
6
A
B
C
D

TABLE 2

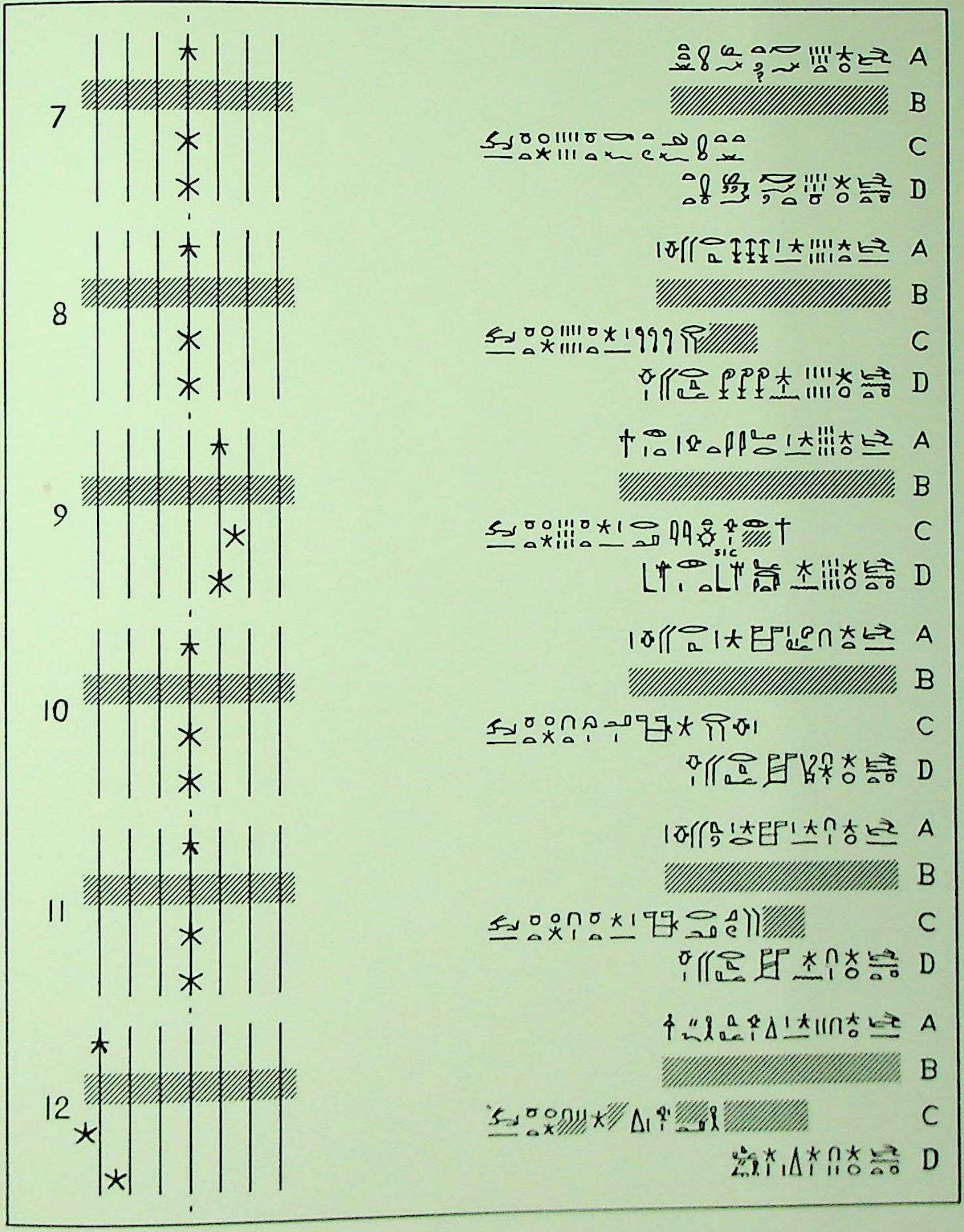
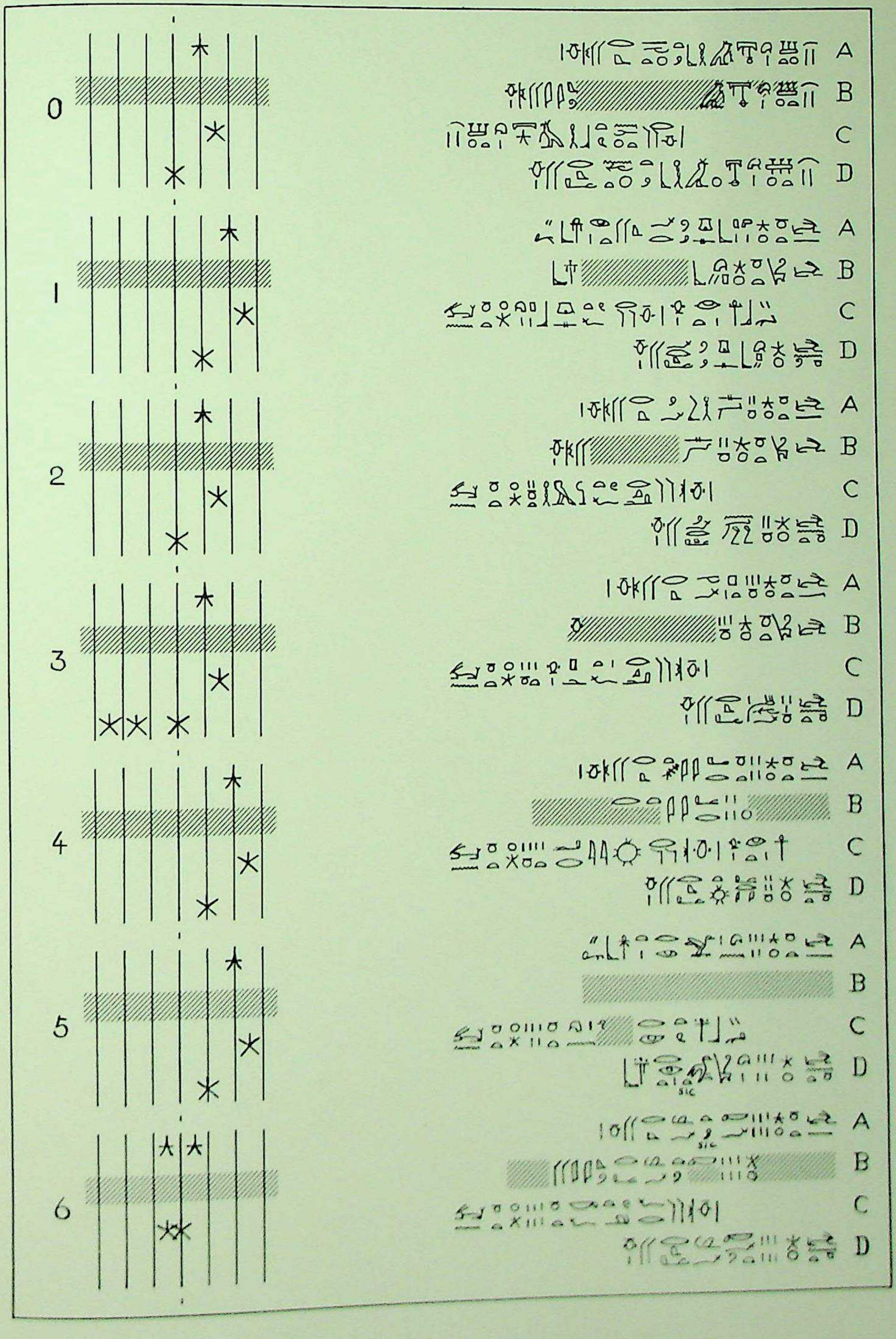

7
A
B
C
D
8
A
B
C
D
9
A
B
C
sic
D
10
A
B
C
D
11
A
B
C
D
12
A
B
C
D

TABLE 3


0
A
B
C
D
1
A
B
C
D
2
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B
C
D
3
A
B
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D
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D
5
A
B
C
D
sic
6
A
sic
B
C
D

TABLE 3

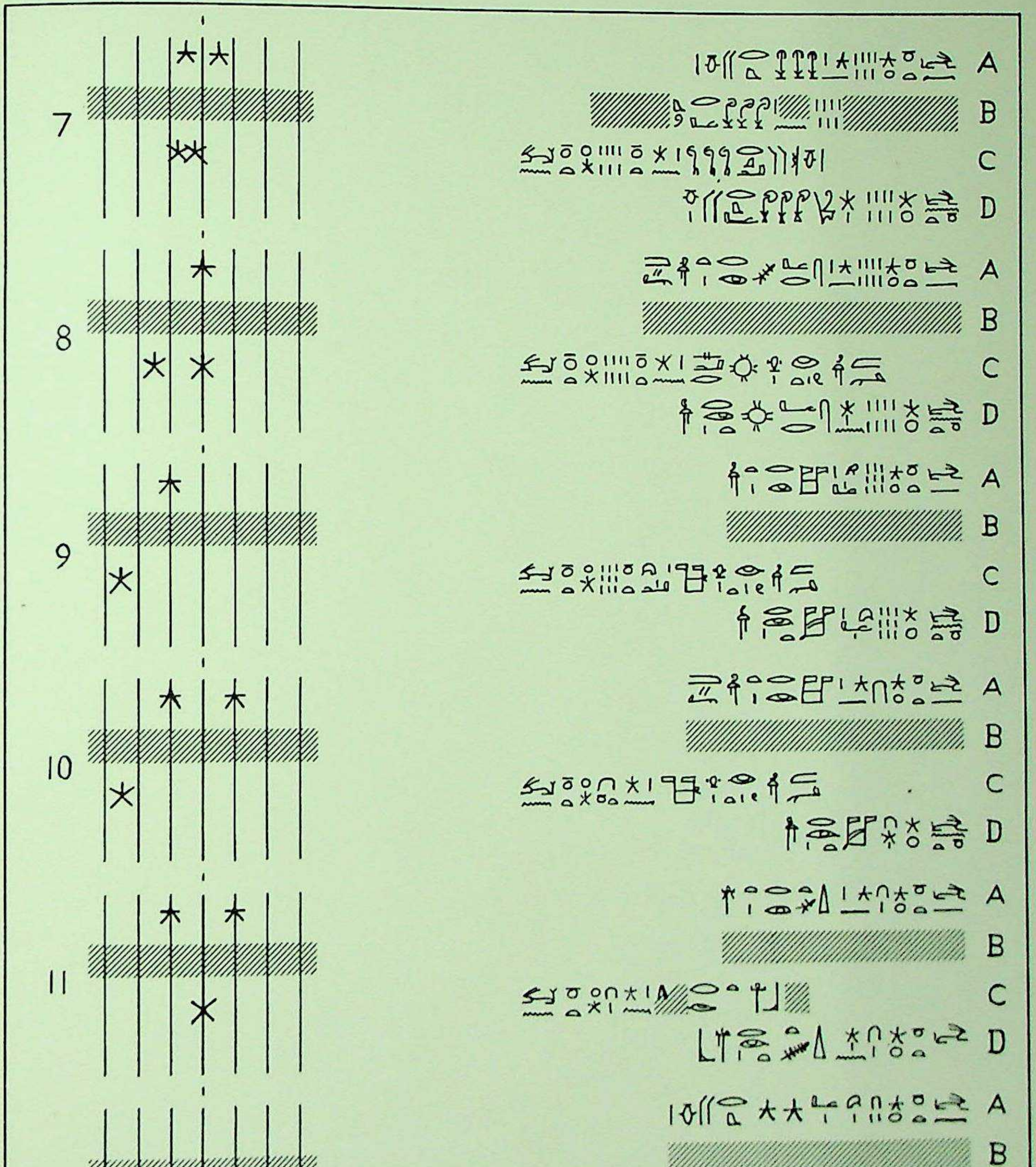
7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D
11
A
B
C
D
12
A
B
C
D

TABLE 4

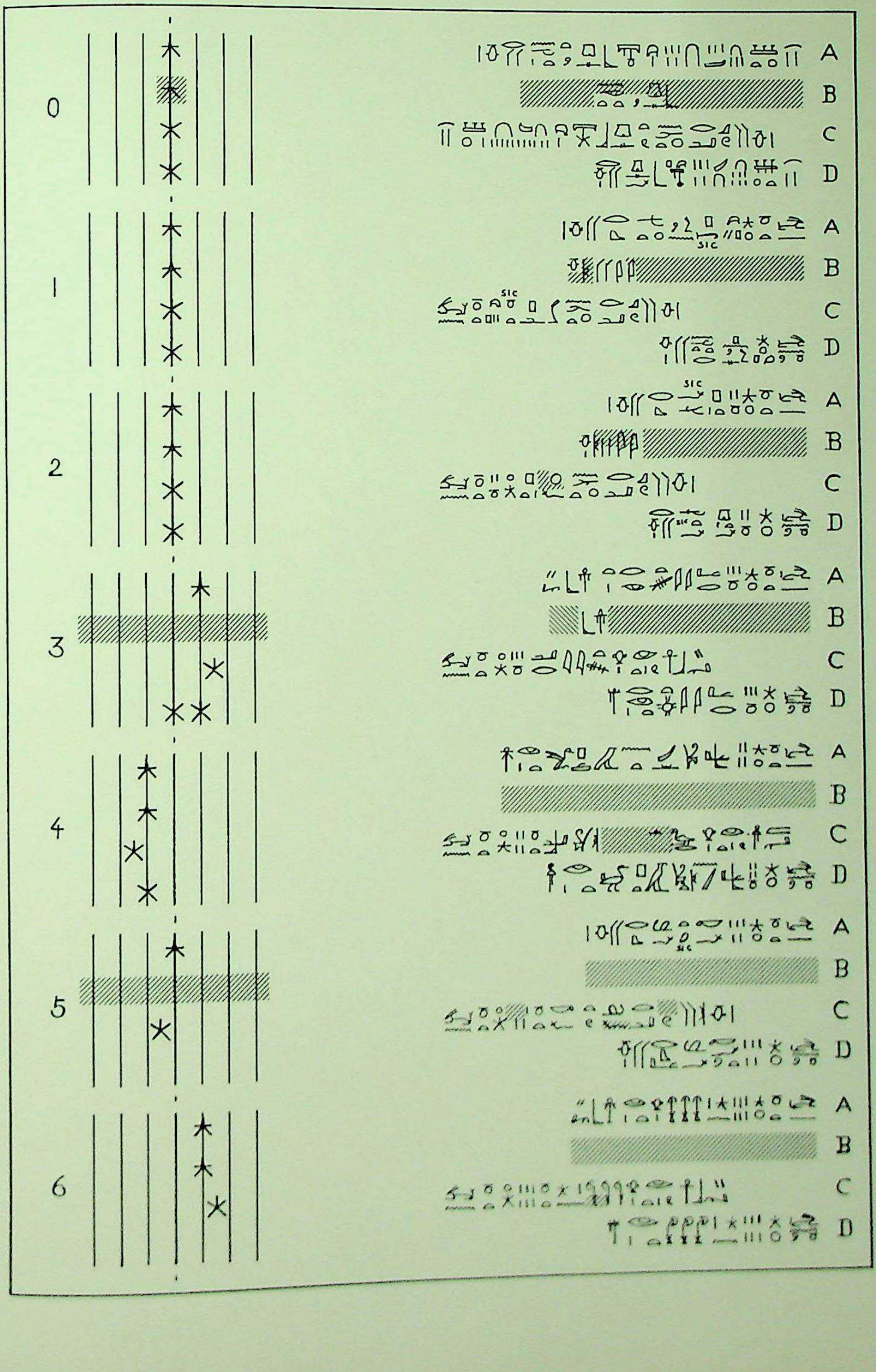
0
A
B
C
D
1
A
sic
B
sic
C
D
2
sic
A
B
C
D
3
A
B
C
D
4
A
B
C
D
5
A
sic
B
C
D
6
A
B
C
D

TABLE 4

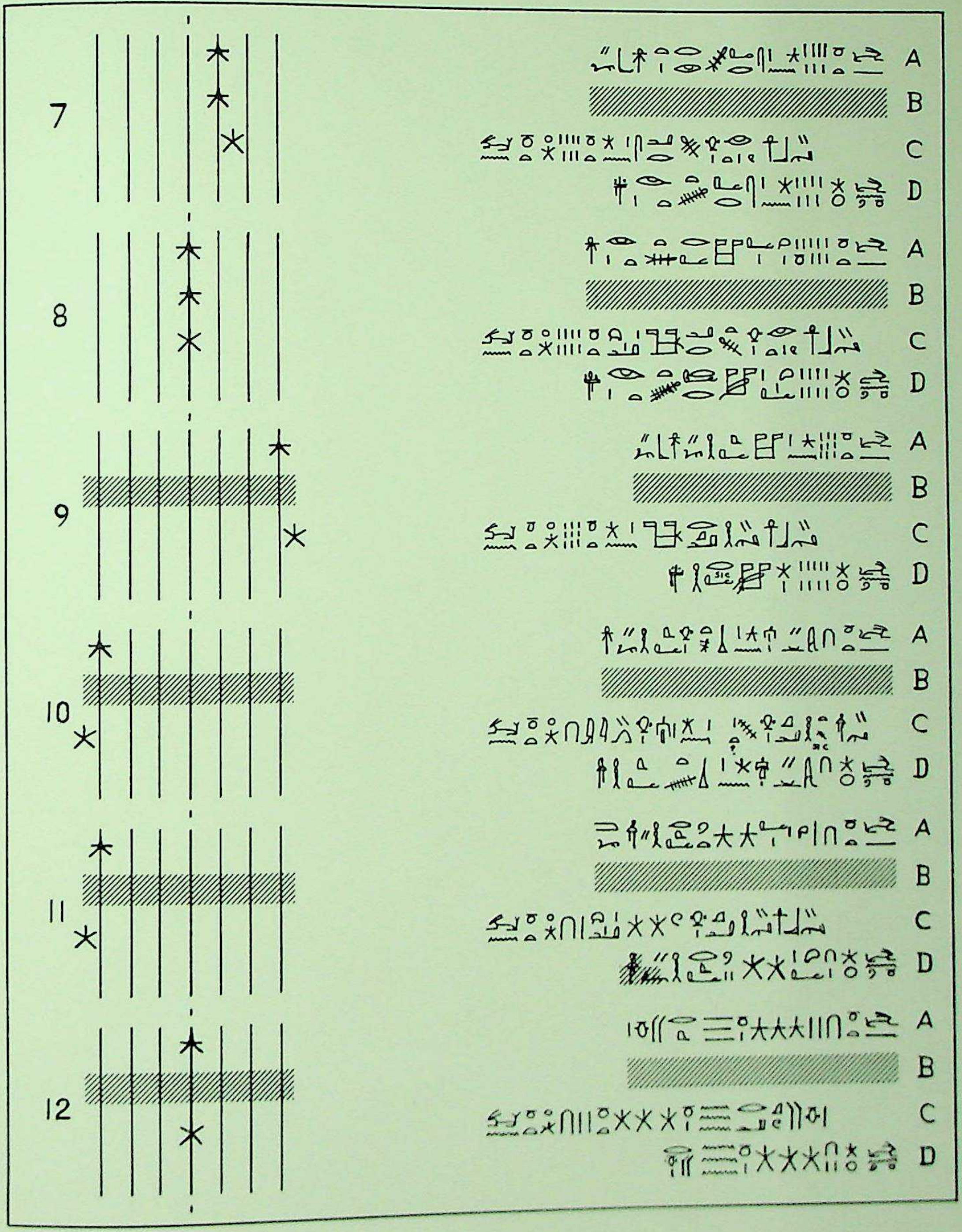
7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D
11
A
B
C
D
12
A
B
C
D

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TABLE 5

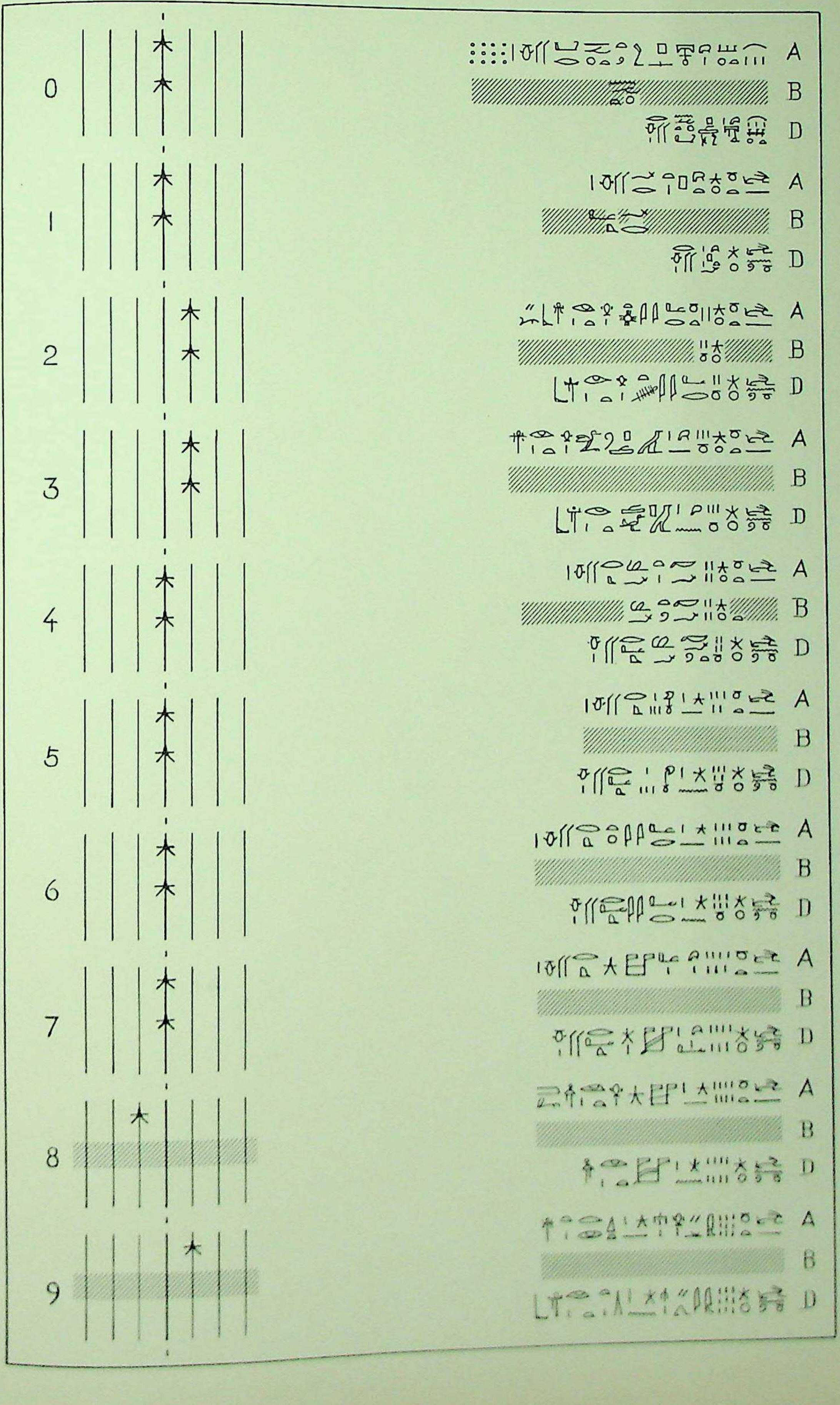

0
A
B
D
1
A
B
D
2
A
B
D
3
A
B
D
4
A
B
D
5
A
B
D
6
A
B
D
7
A
B
D
8
A
B
D
9
A
B
D

TABLE 5

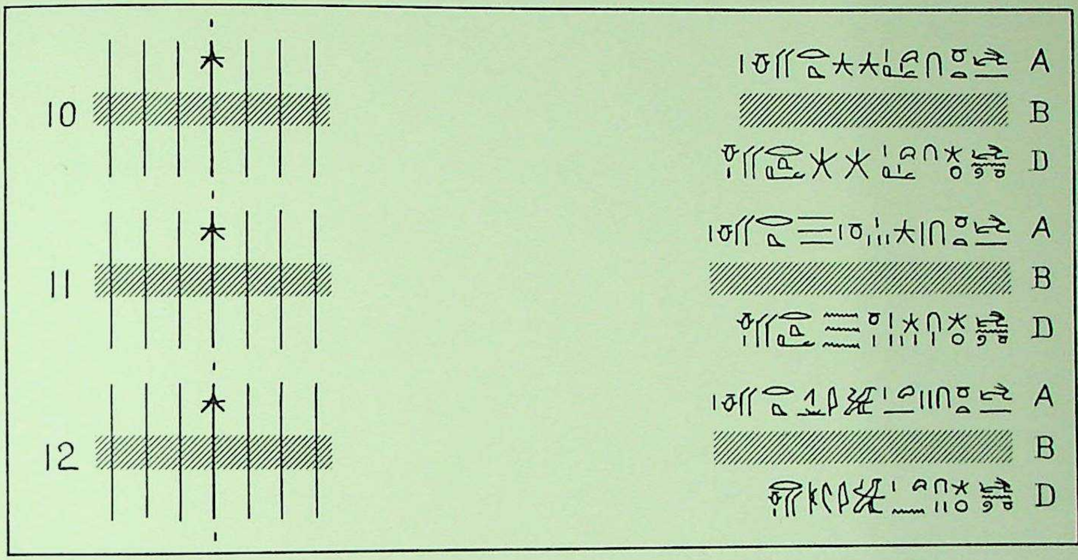

10
11
12
A
B
D
A
B
D
A
B
D

TABLE 6

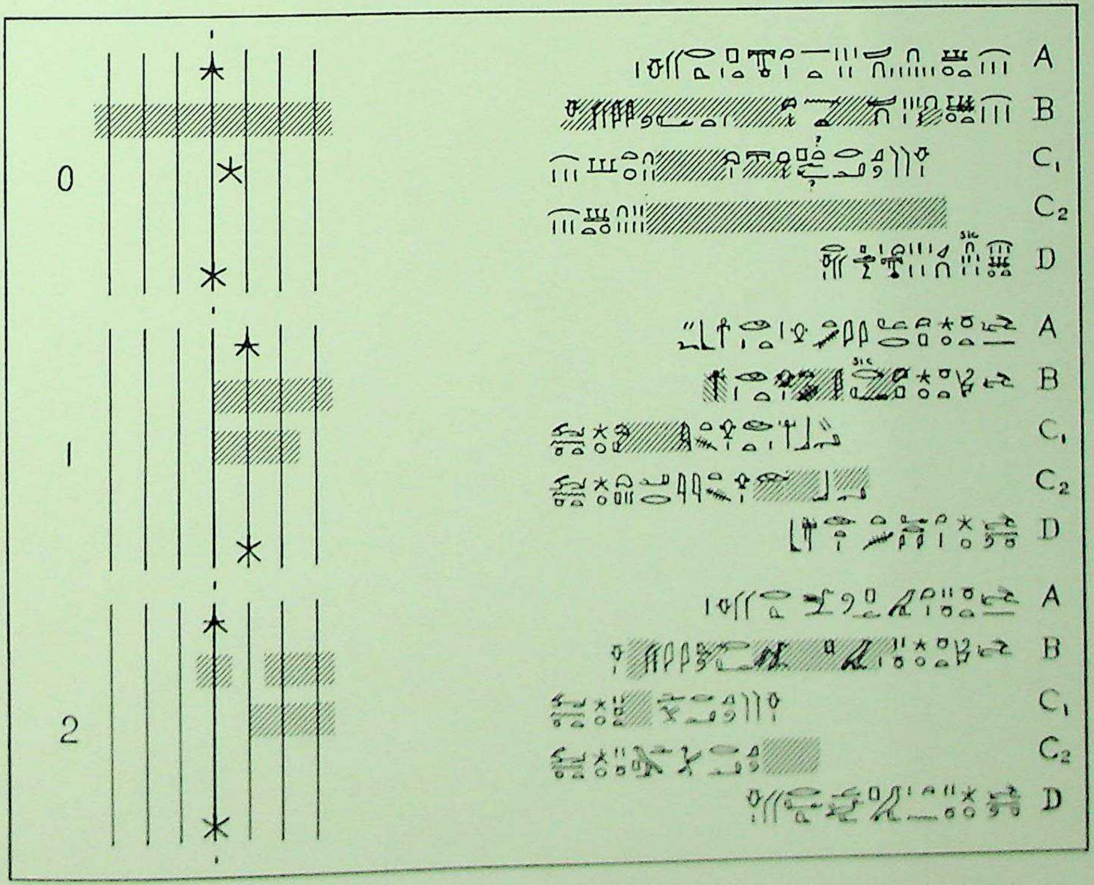

0
1
2
A
B
C₁
C₂
D
sic
A
B
C₁
C₂
D
sic
A
B
C₁
C₂
D

TABLE 6

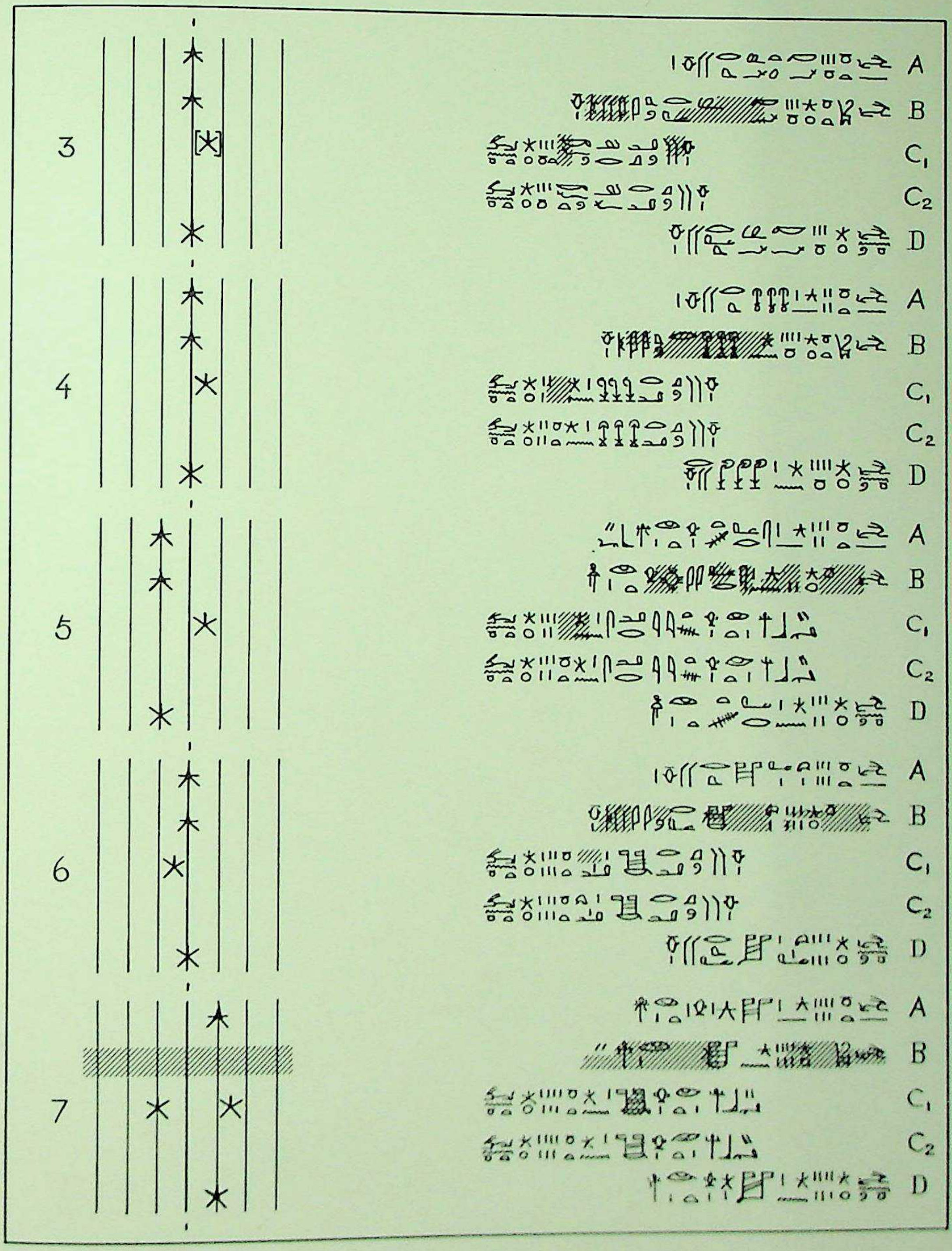

3
A
B
C1
C2
D
4
A
B
C1
C2
D
5
A
B
C1
C2
D
6
A
B
C1
C2
D
7
A
B
C1
C2
D

TABLE 6

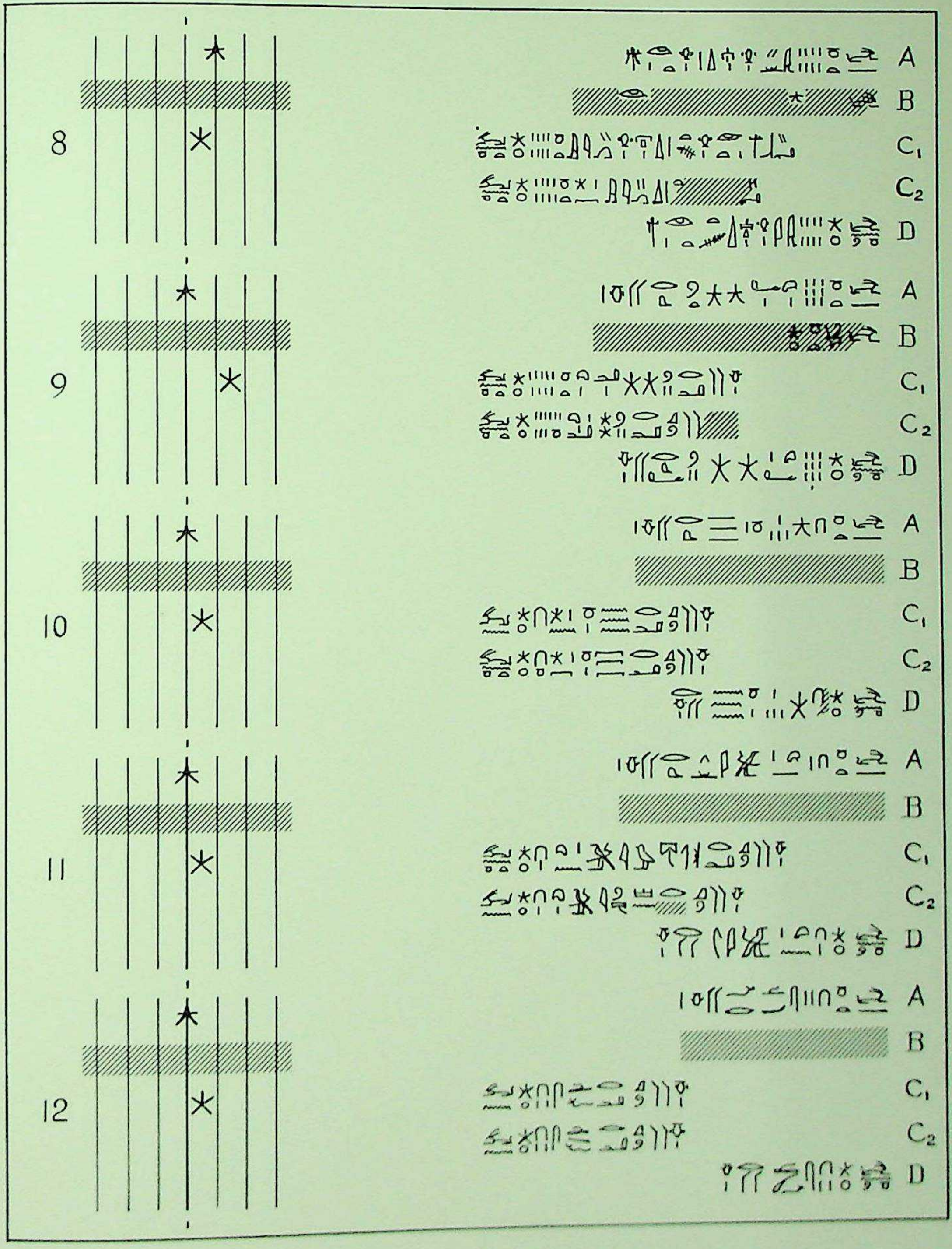

8
A
B
C1
C2
D
9
A
B
C1
C2
D
10
A
B
C1
C2
D
11
A
B
C1
C2
D
12
A
B
C1
C2
D

TABLE 7

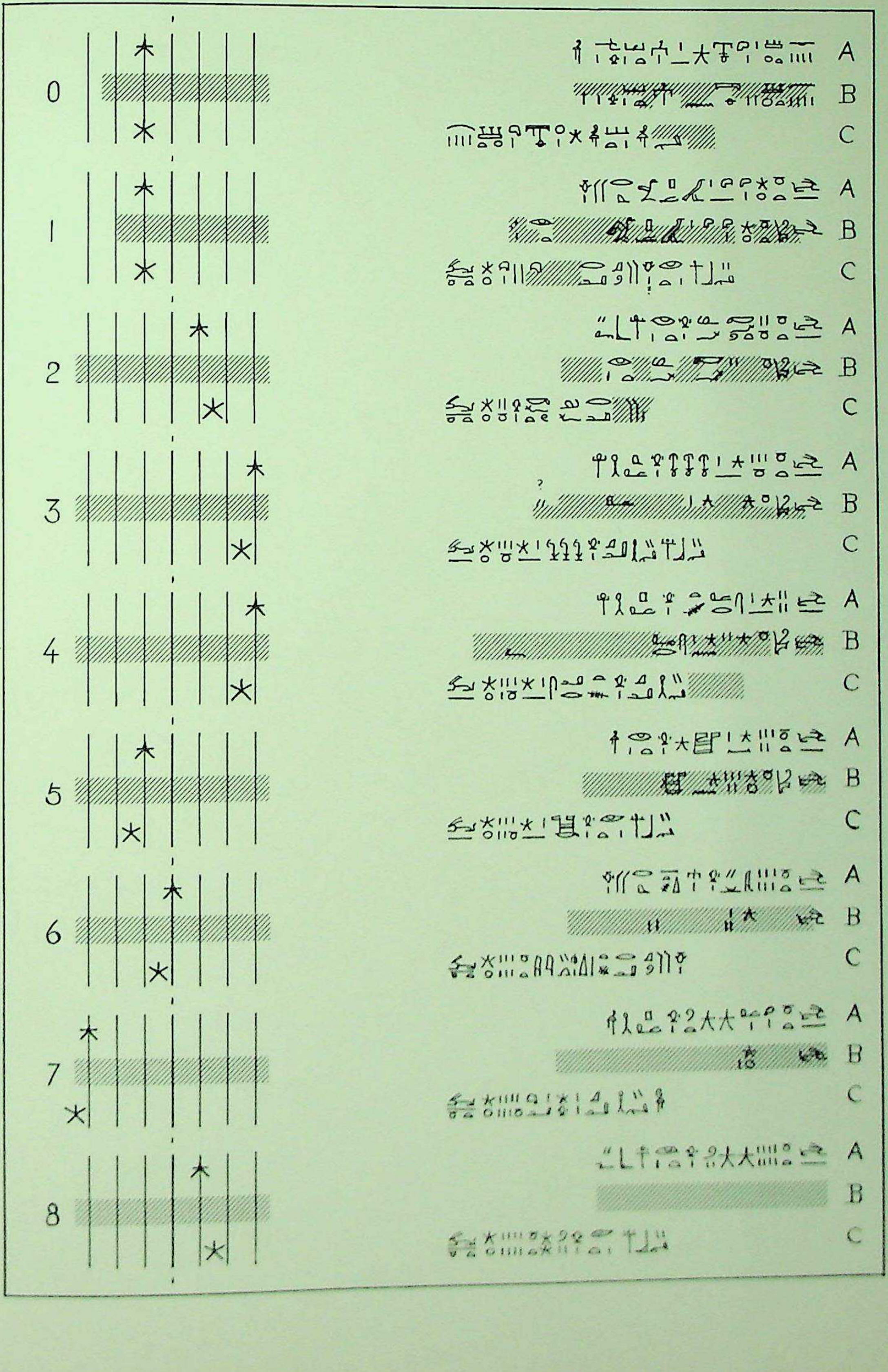

0
1
2
3
4
5
6
7
8
A
B
C
?

TABLE 7

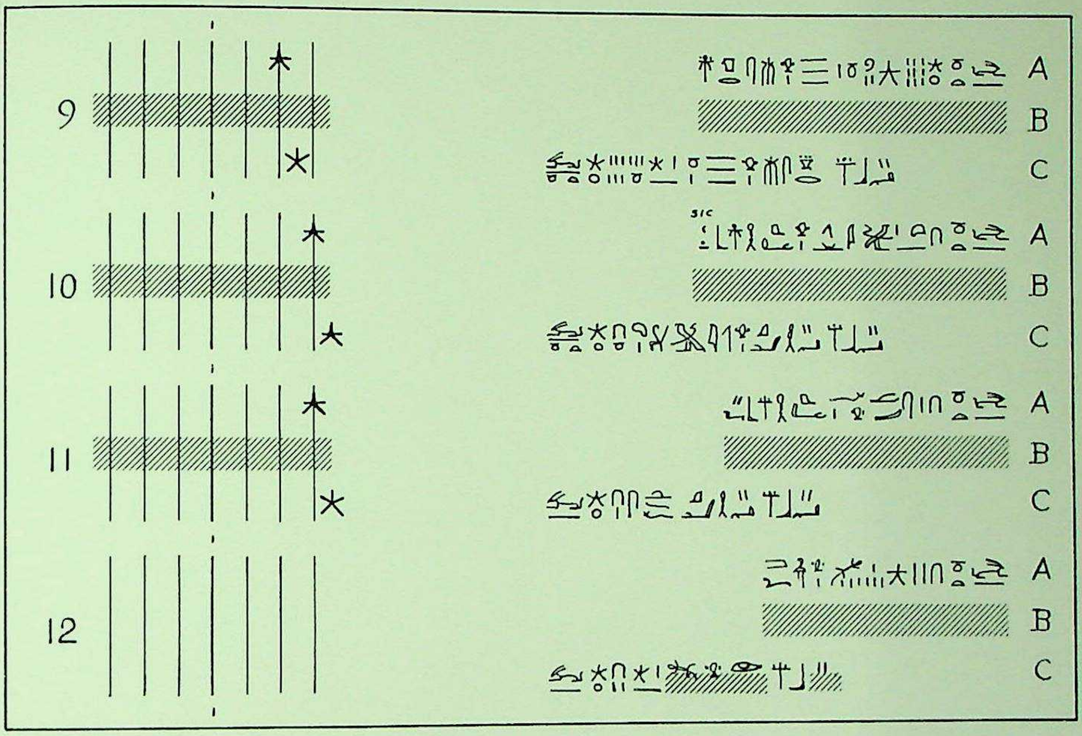

9
10
11
12
A
B
C
sic

TABLE 8

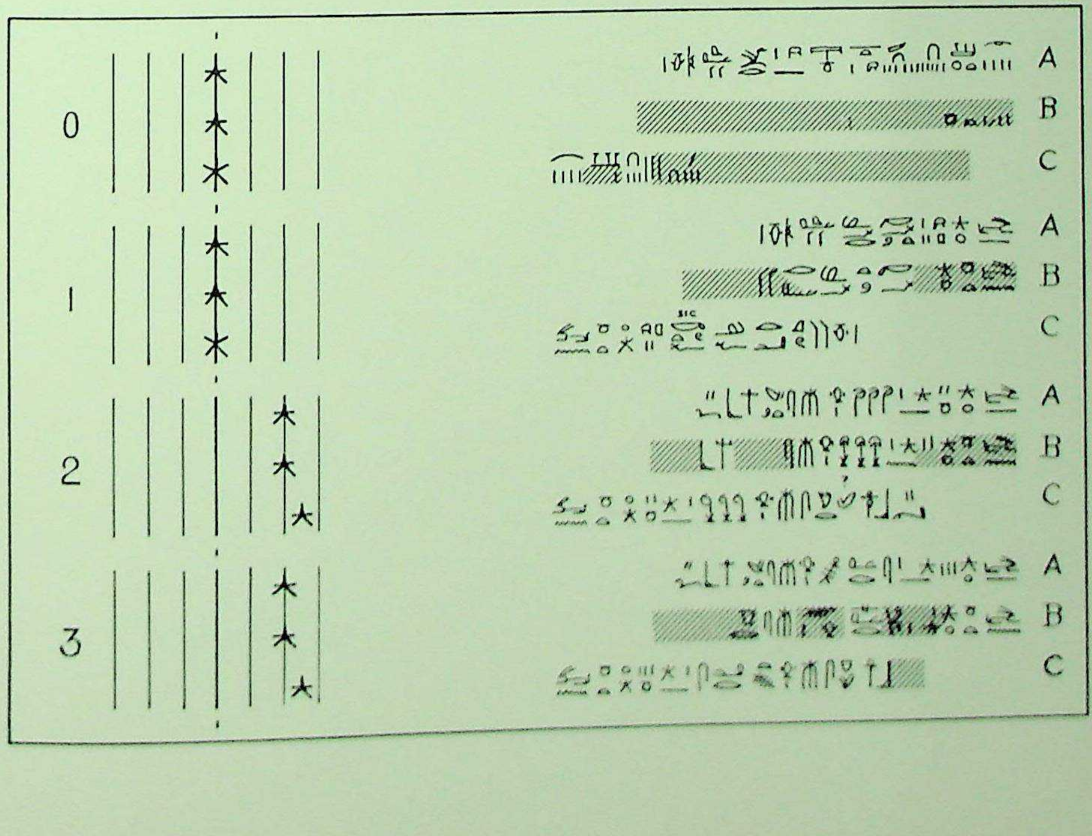

0
1
2
3
A
B
C
sic

TABLE 8

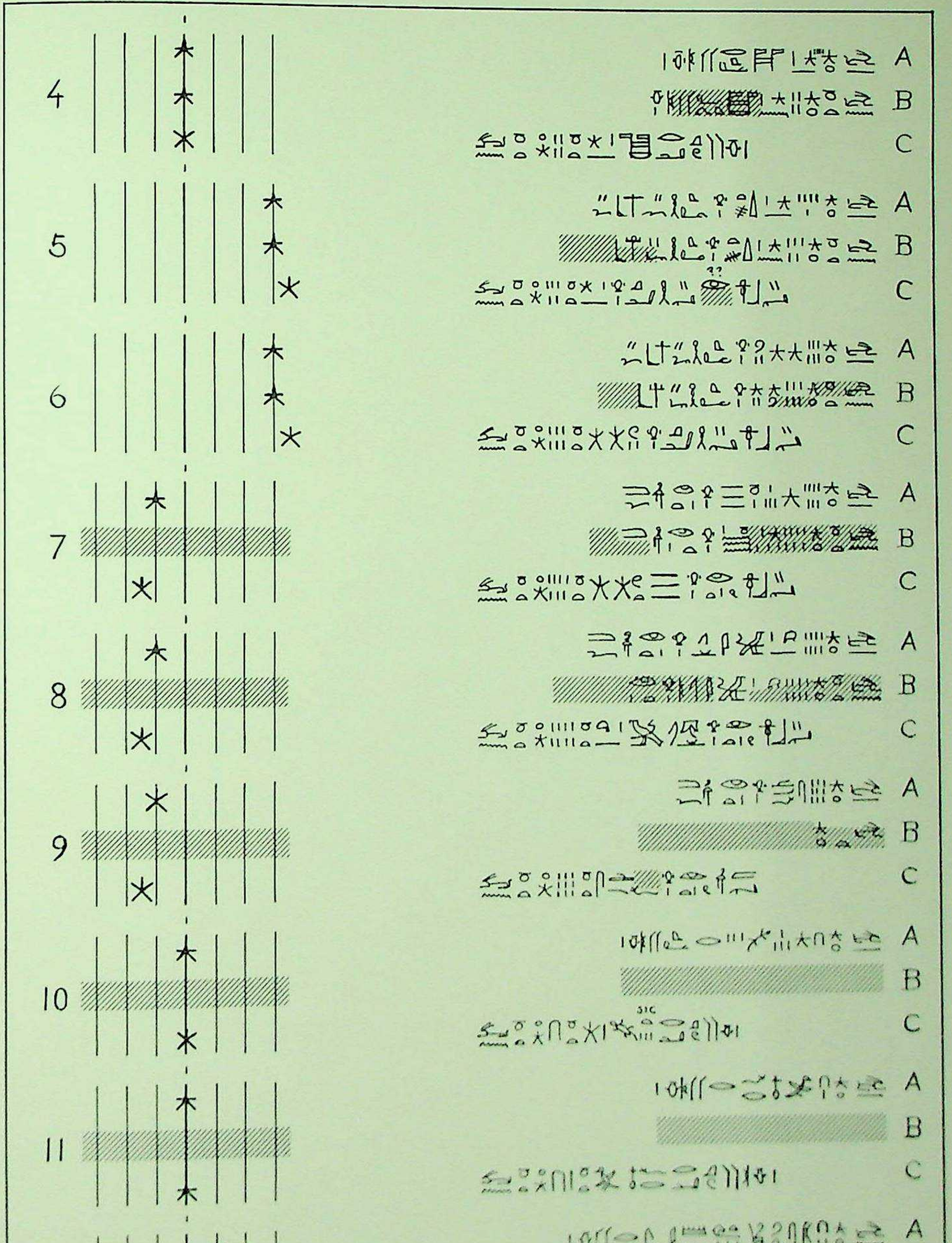

4
5
6
7
8
9
10
11
12
A
B
C
sic

TABLE 9

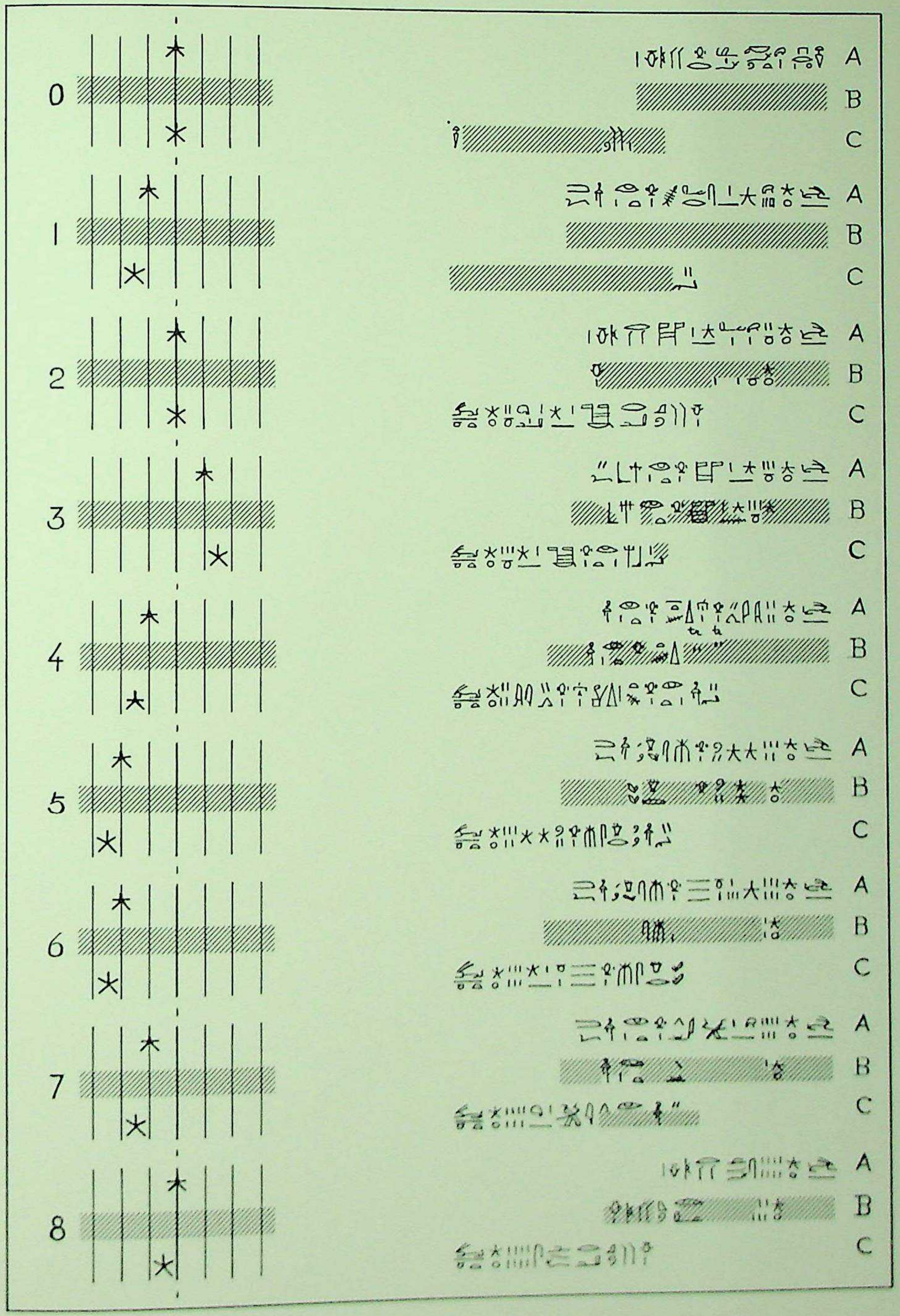

0
1
2
3
4
5
6
7
8
A
B
C

TABLE 9

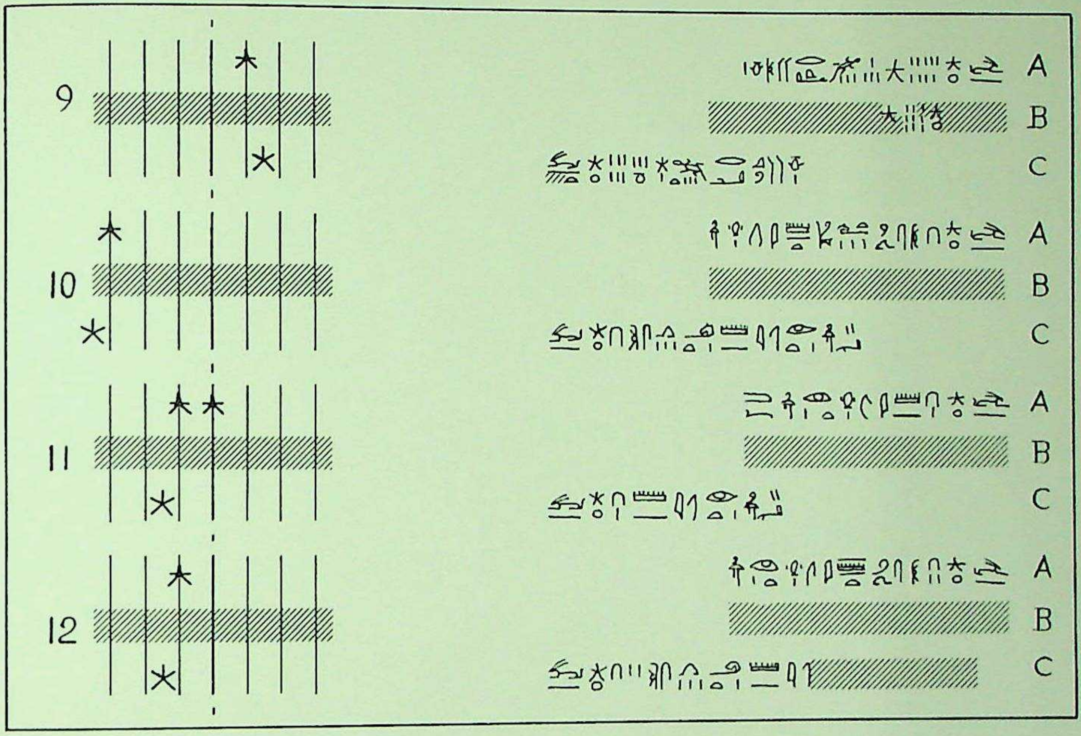

9
A
B
C
10
A
B
C
11
A
B
C
12
A
B
C

TABLE 10

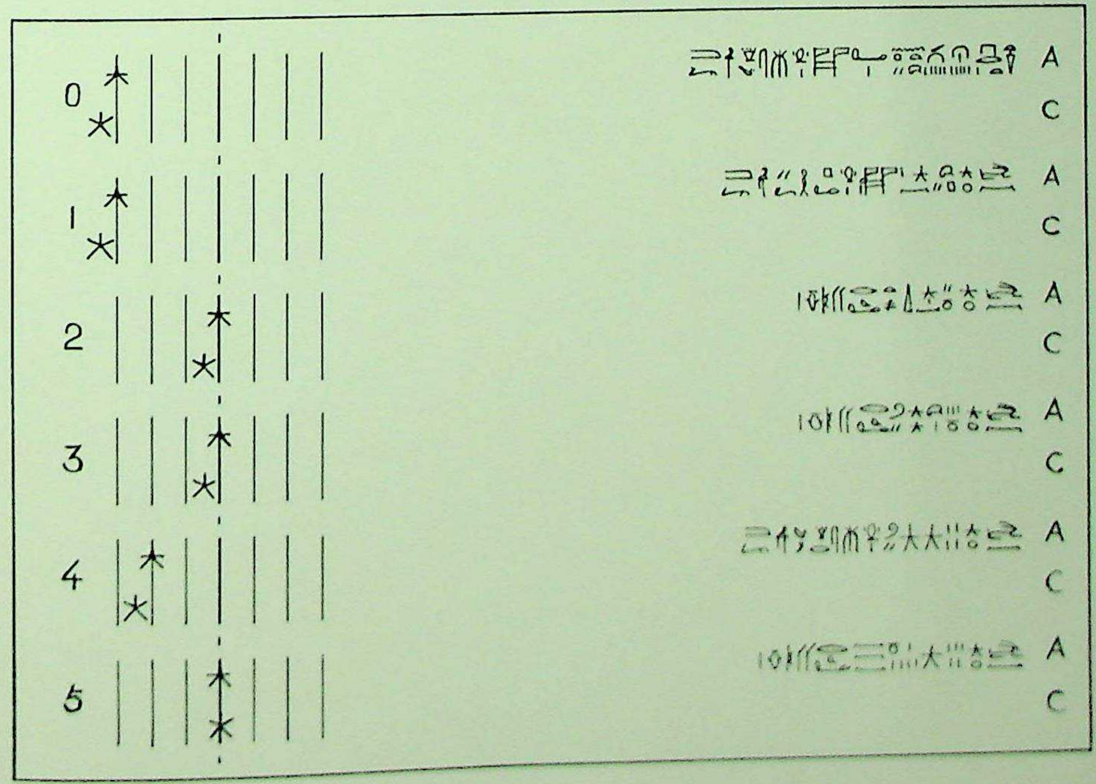

0
A
C
1
A
C
2
A
C
3
A
C
4
A
C
5
A
C

TABLE 10

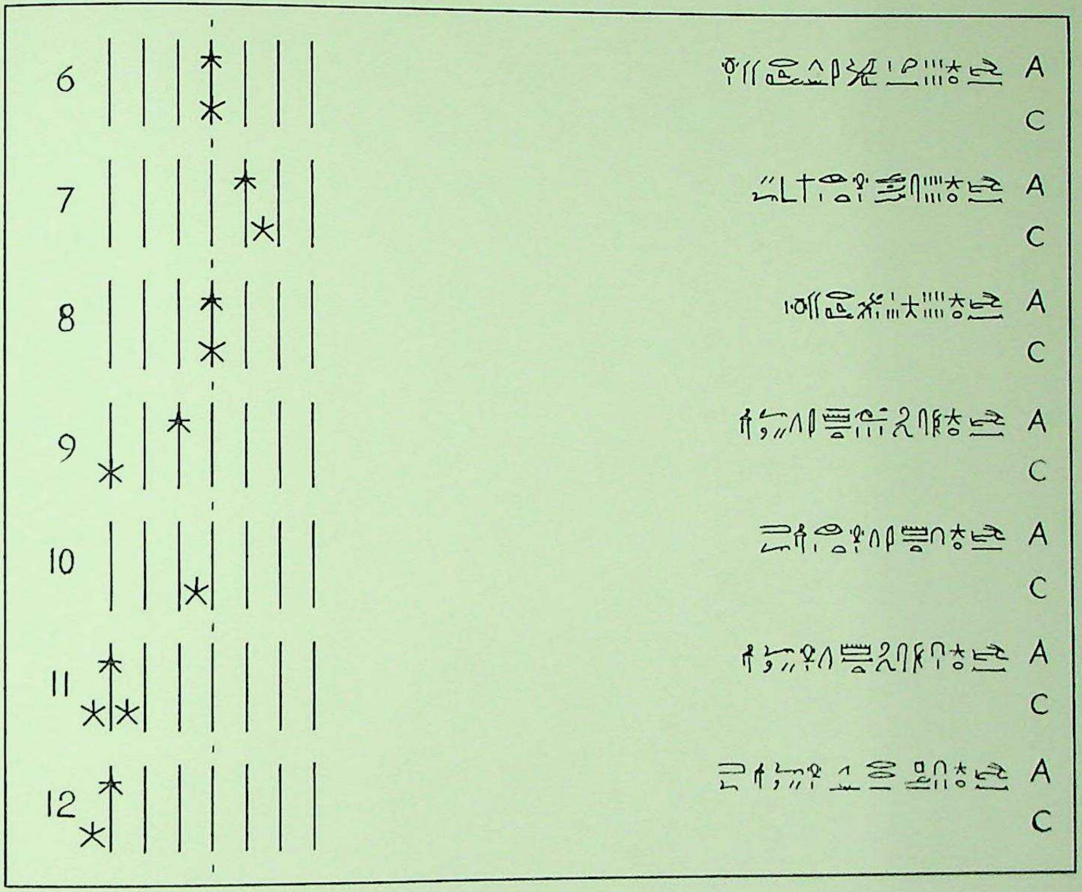

6
A
C
7
A
C
8
A
C
9
A
C
10
A
C
11
A
C
12
A
C

TABLE 11

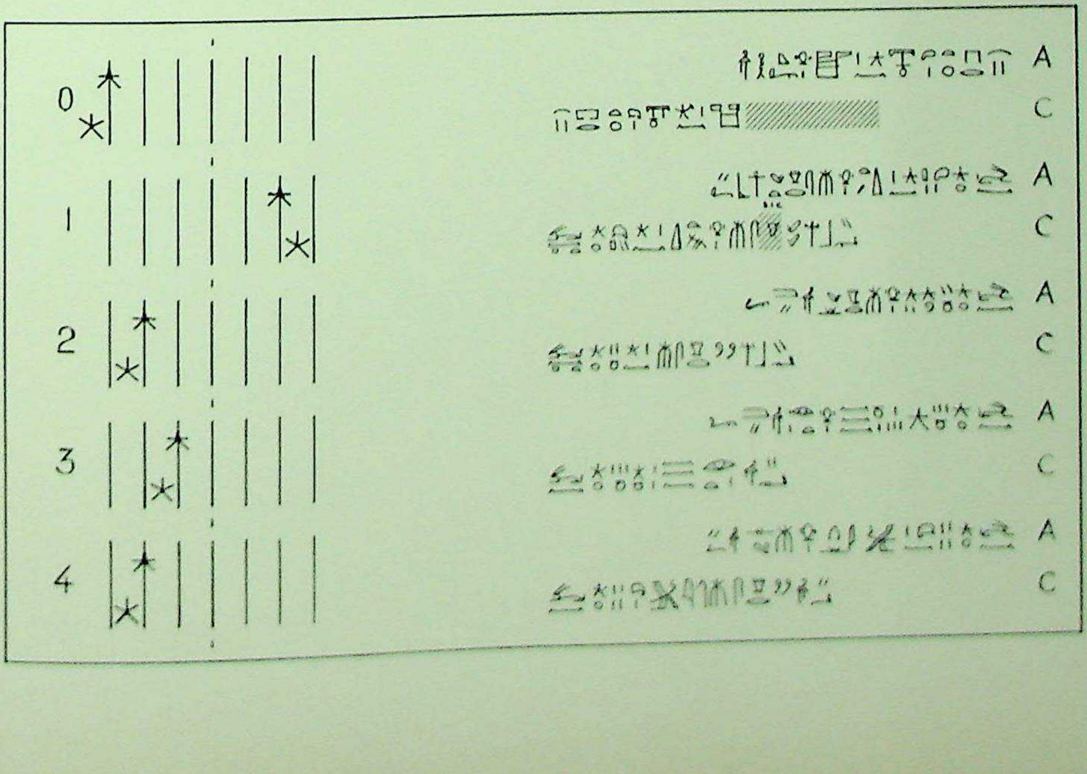

0
A
C
1
A
C
2
A
C
3
A
C
4
A
C

TABLE 11

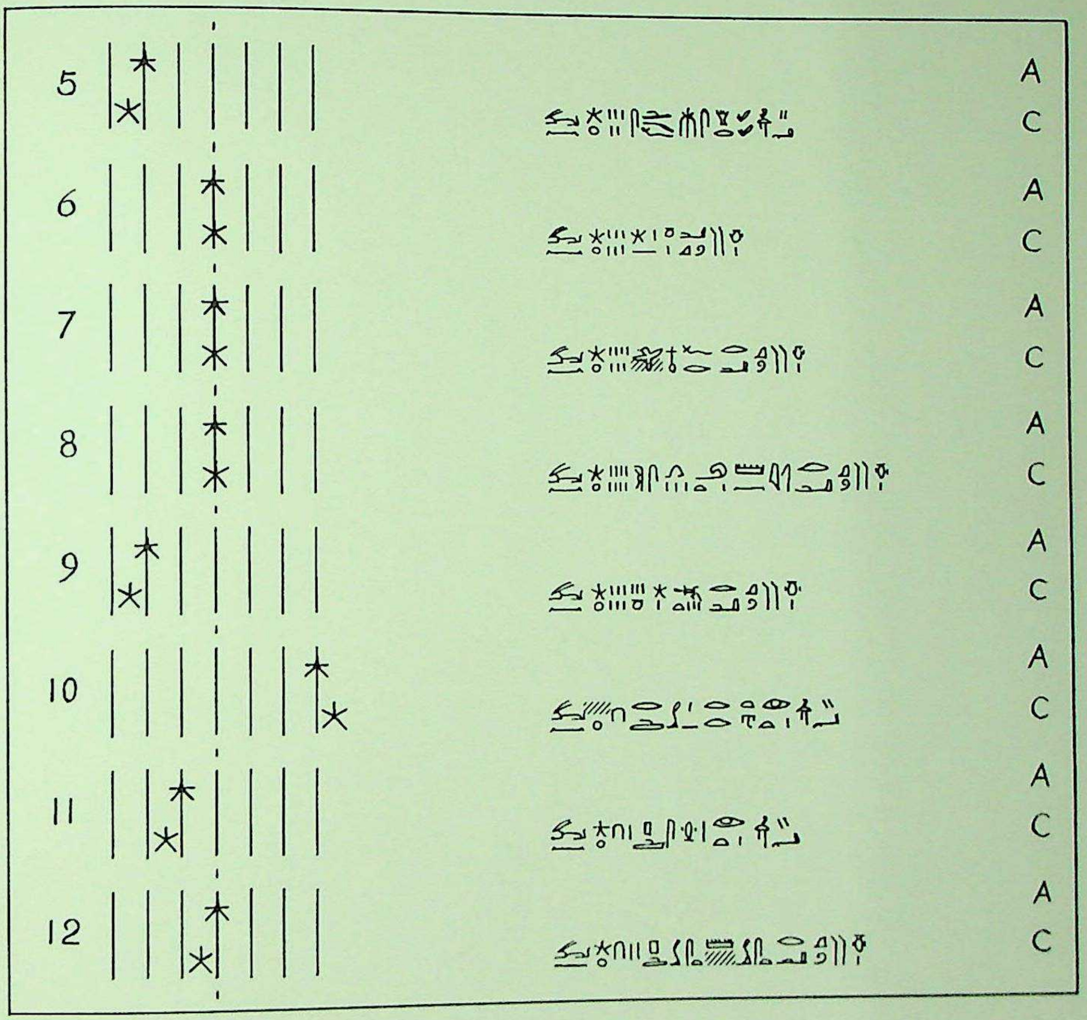

5
A
C
6
A
C
7
A
C
8
A
C
9
A
C
10
A
C
11
A
C
12
A
C

TABLE 12

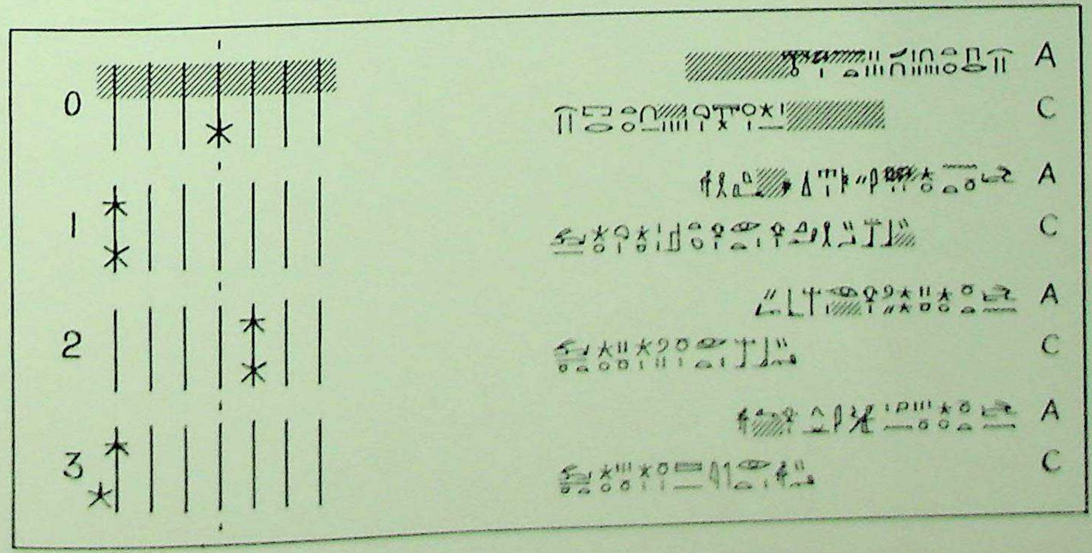
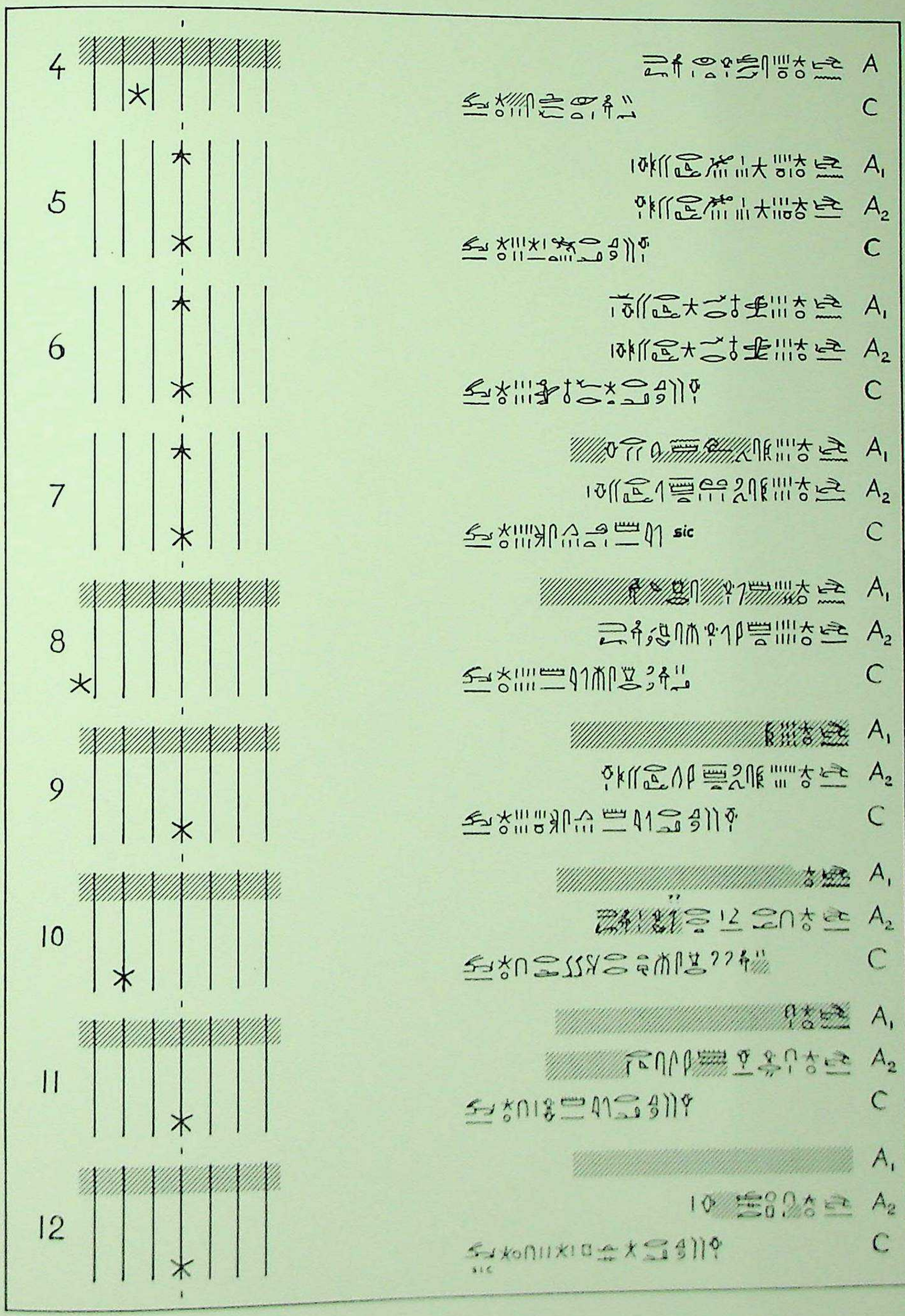

0
A
C
1
A
C
2
A
C
3
A
C

TABLE 12


4
A
C
5
A$_1$
A$_2$
C
6
A$_1$
A$_2$
C
7
A$_1$
A$_2$
sic
C
8
A$_1$
A$_2$
C
9
A$_1$
A$_2$
C
10
A$_1$
A$_2$
C
11
A$_1$
A$_2$
C
12
A$_1$
A$_2$
sic
C

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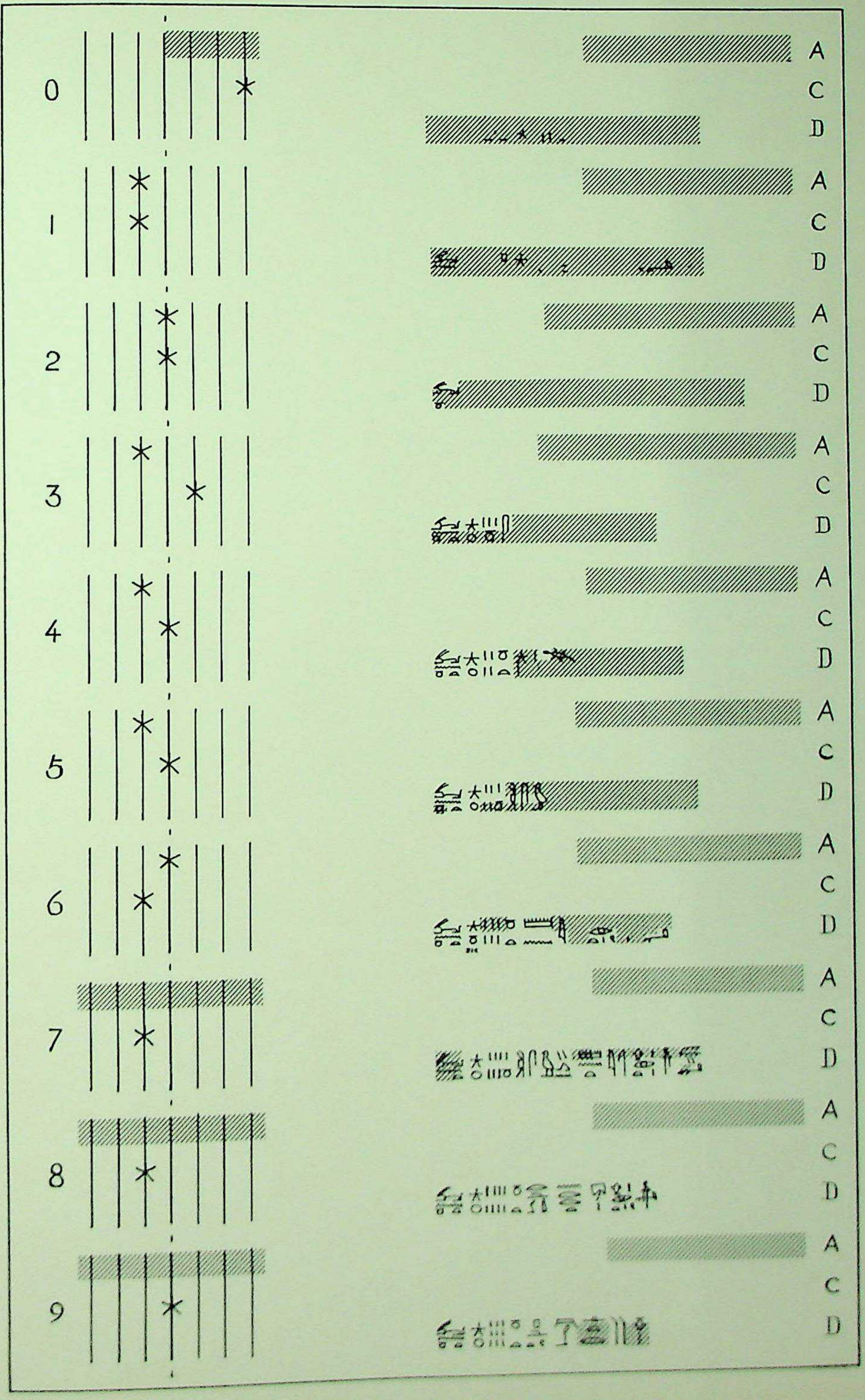
0
A
C
D
1
A
C
D
2
A
C
D
3
A
C
D
4
A
C
D
5
A
C
D
6
A
C
D
7
A
C
D
8
A
C
D
9
A
C
D

TABLE 13

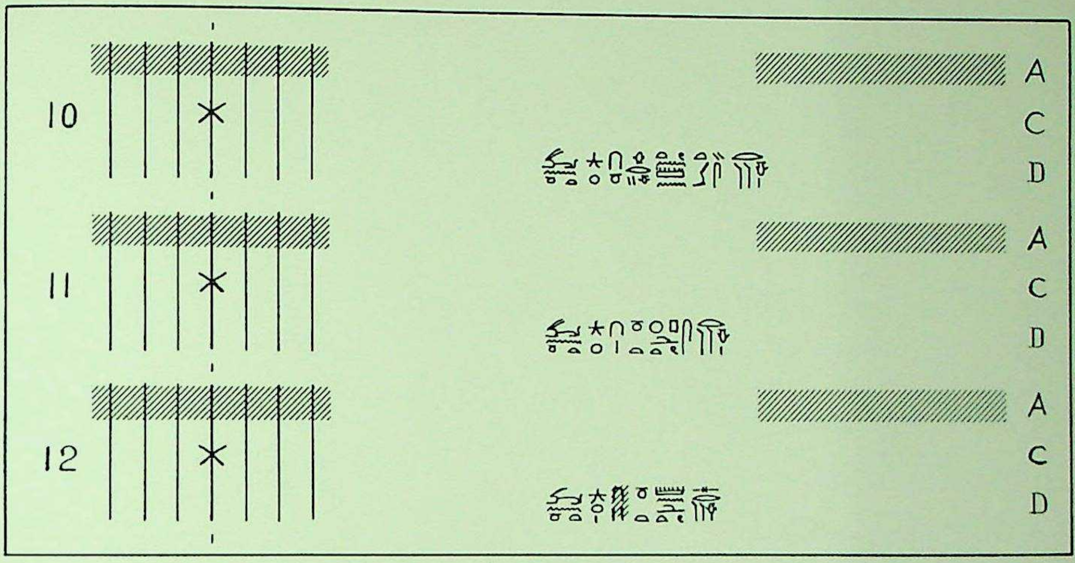
10
11
12
A
C
D
A
C
D
A
C
D

TABLE 14

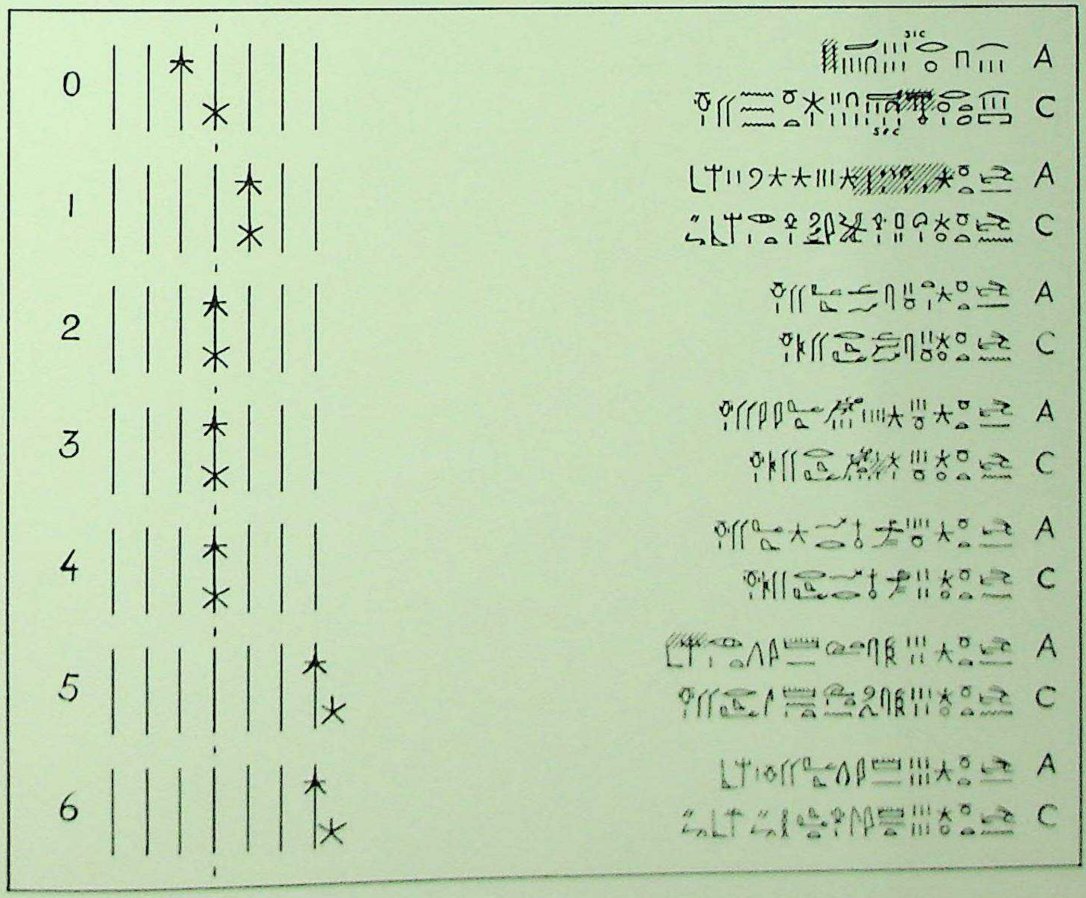
0
1
2
3
4
5
6
sic
sic
A
C
A
C
A
C
A
C
A
C
A
C
A
C

TABLE 14

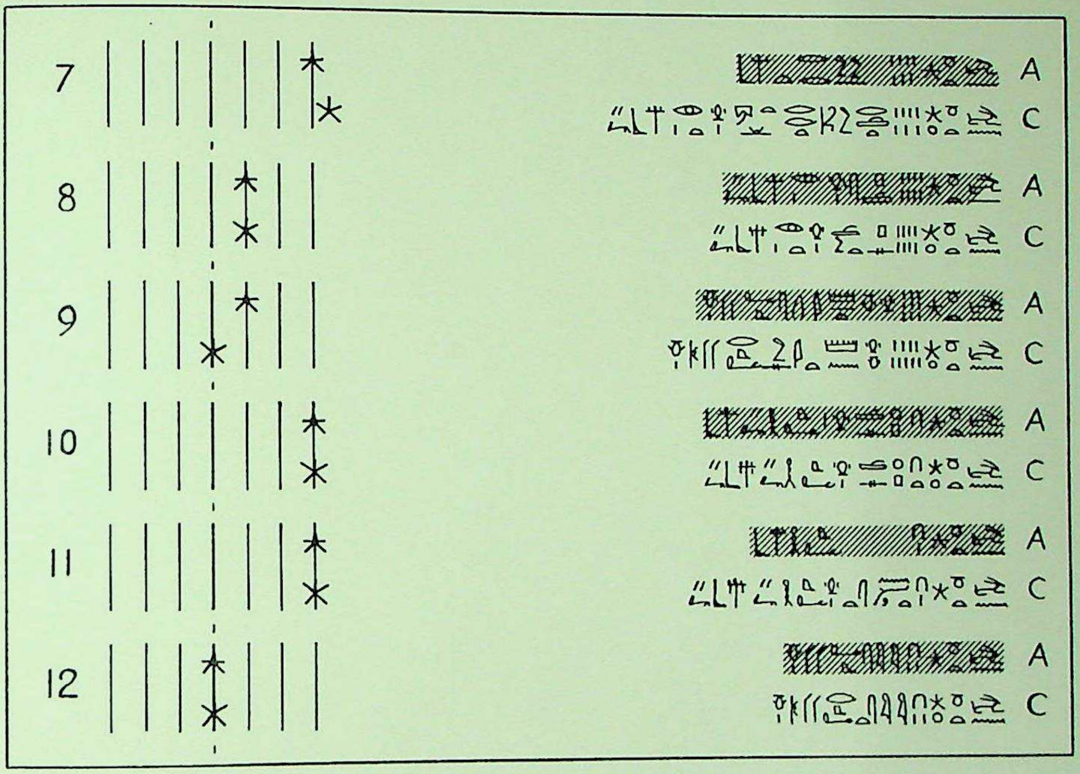
7
A
C
8
A
C
9
A
C
10
A
C
11
A
C
12
A
C

TABLE 15

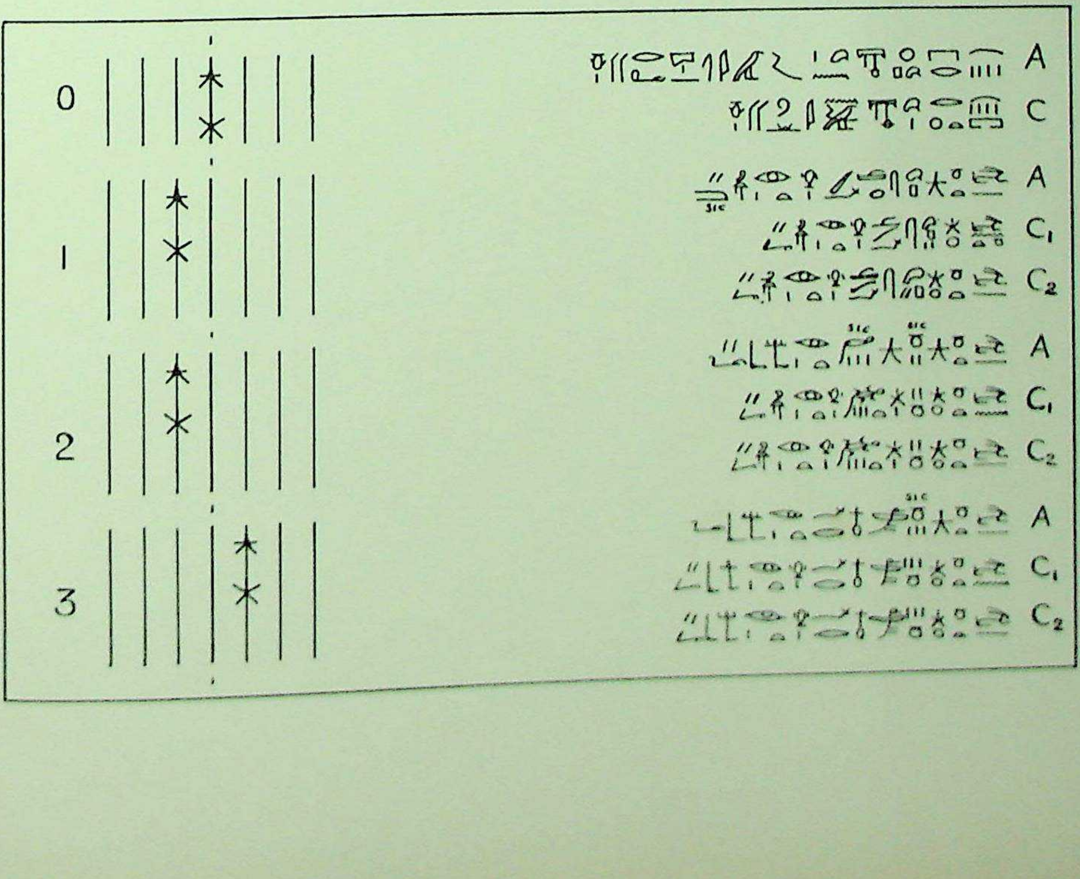
0
A
C
1
A
sic
C₁
C₂
2
sic
sic
A
C₁
C₂
3
sic
A
C₁
C₂

TABLE 15

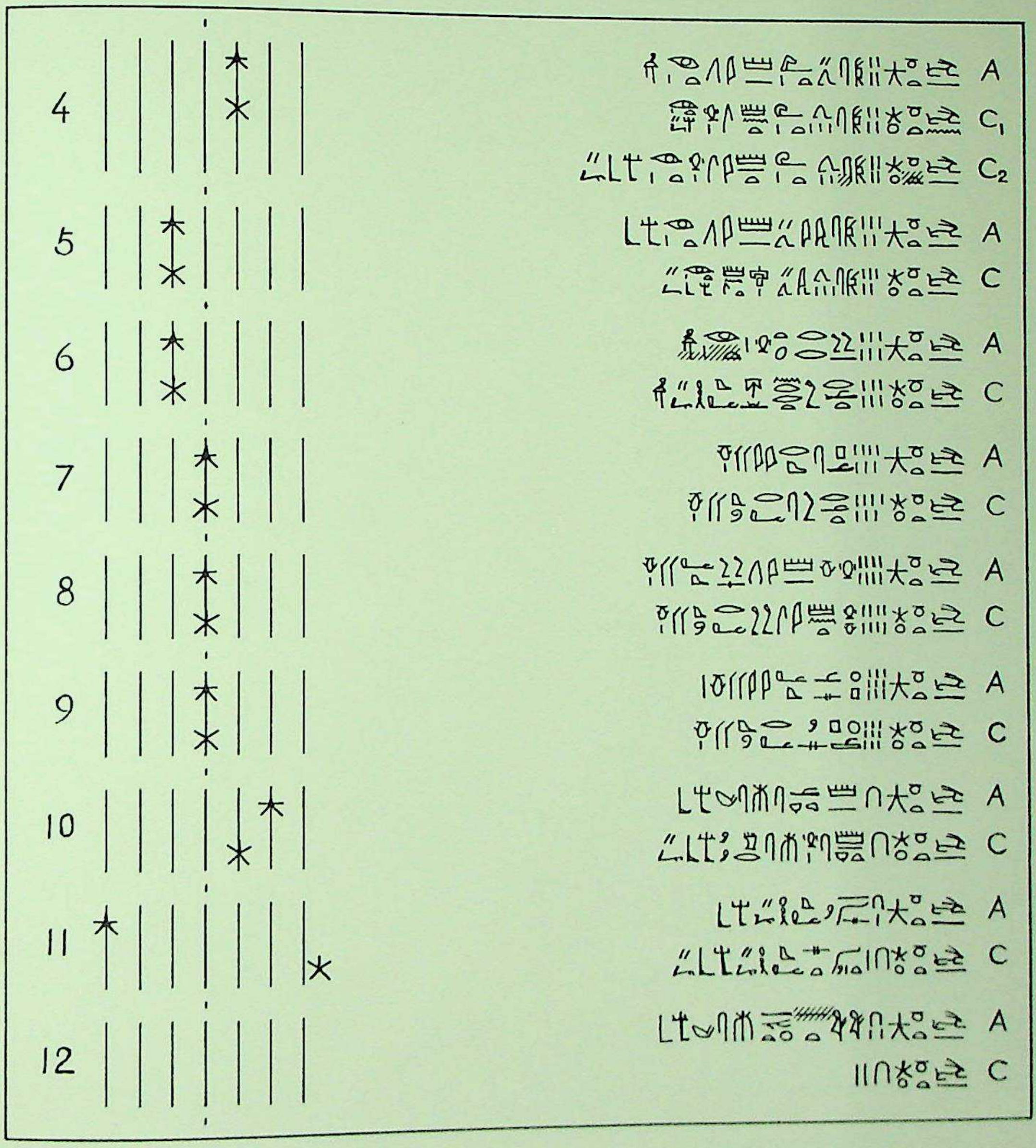
4
A
C1
C2
5
A
C
6
A
C
7
A
C
8
A
C
9
A
C
10
A
C
11
A
C
12
A
C

TABLE 16

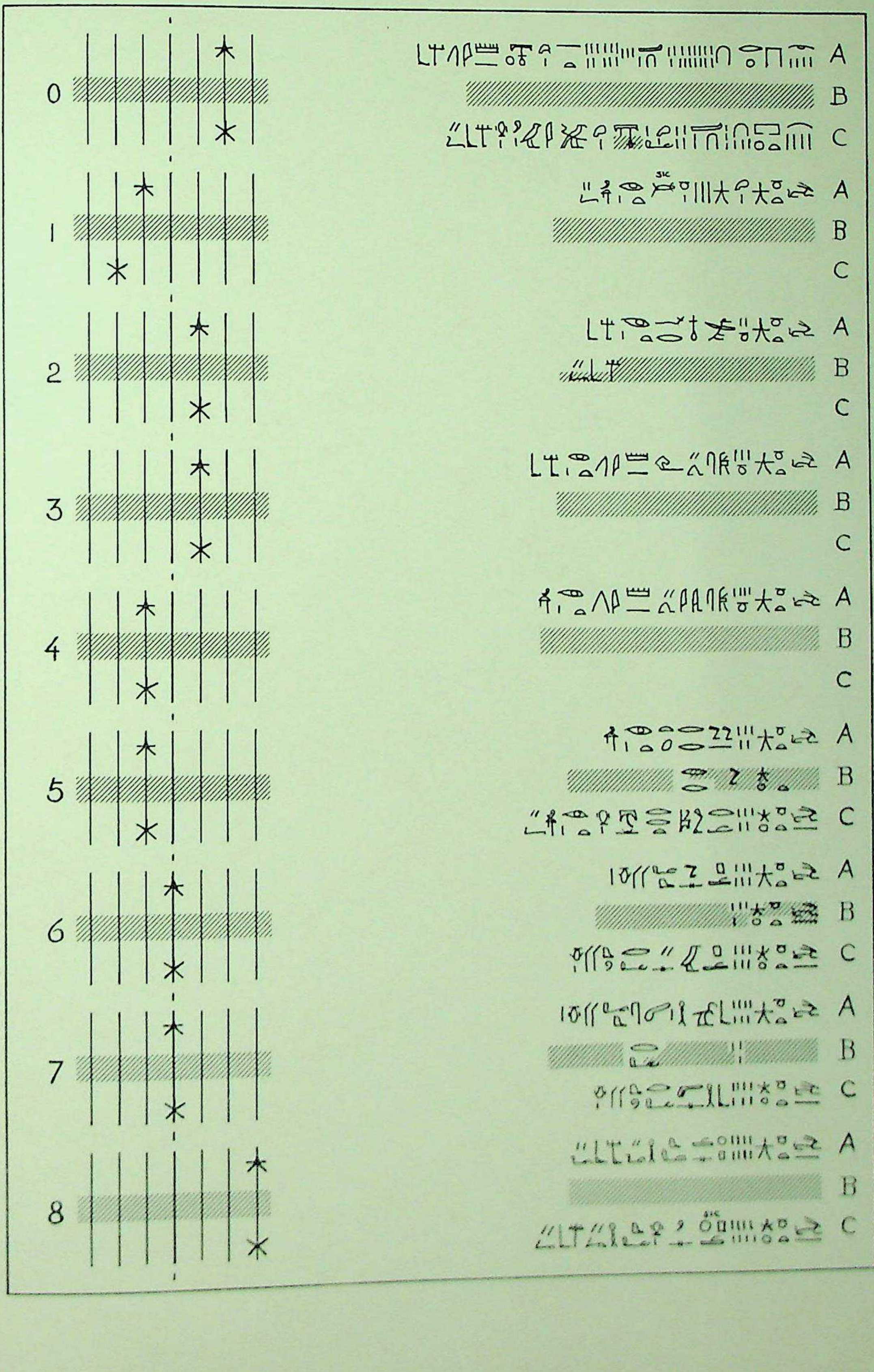
0
A
B
C
1
A
B
C
2
A
B
C
3
A
B
C
4
A
B
C
5
A
B
C
6
A
B
C
7
A
B
C
8
A
B
C
sic
sic

TABLE 16

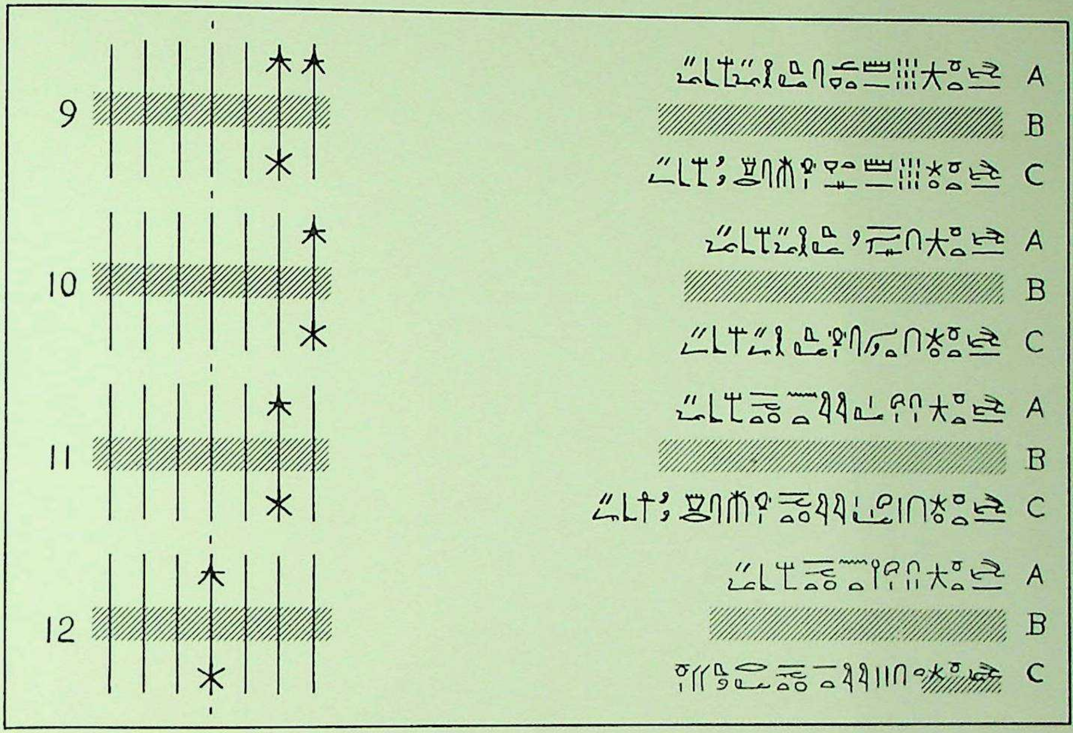
9
A
B
C
10
A
B
C
11
A
B
C
12
A
B
C

TABLE 17

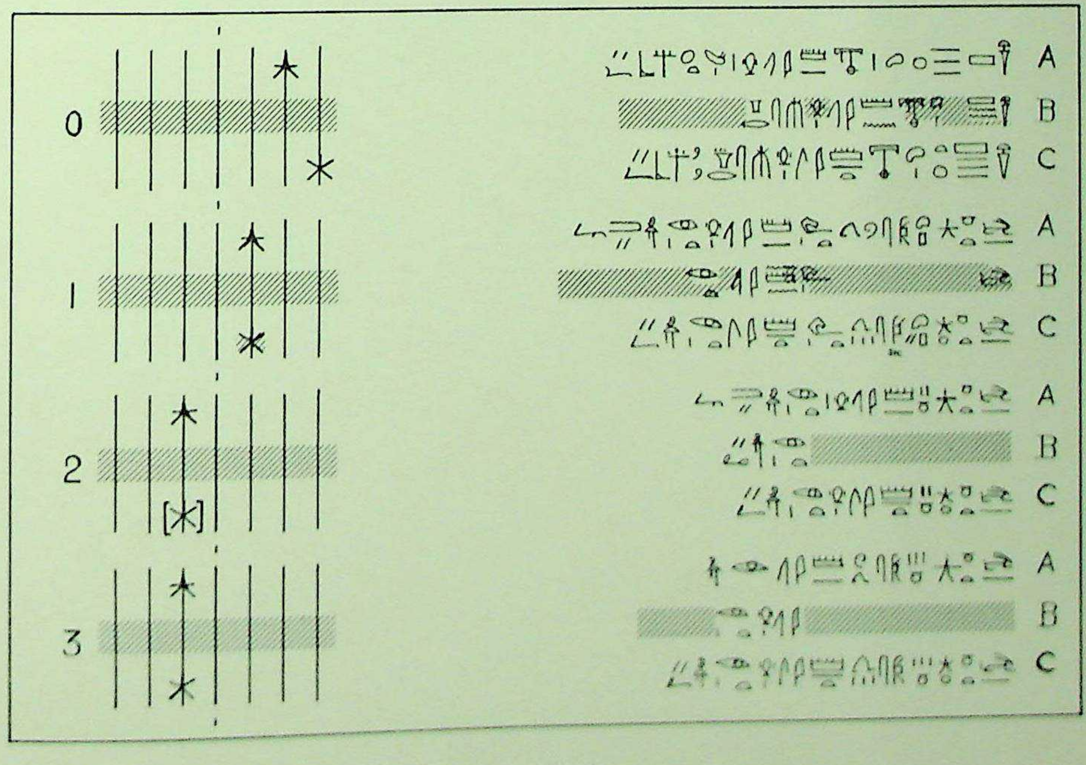
0
A
B
C
1
A
B
C
2
[×]
A
B
C
3
A
B
C

TABLE 17

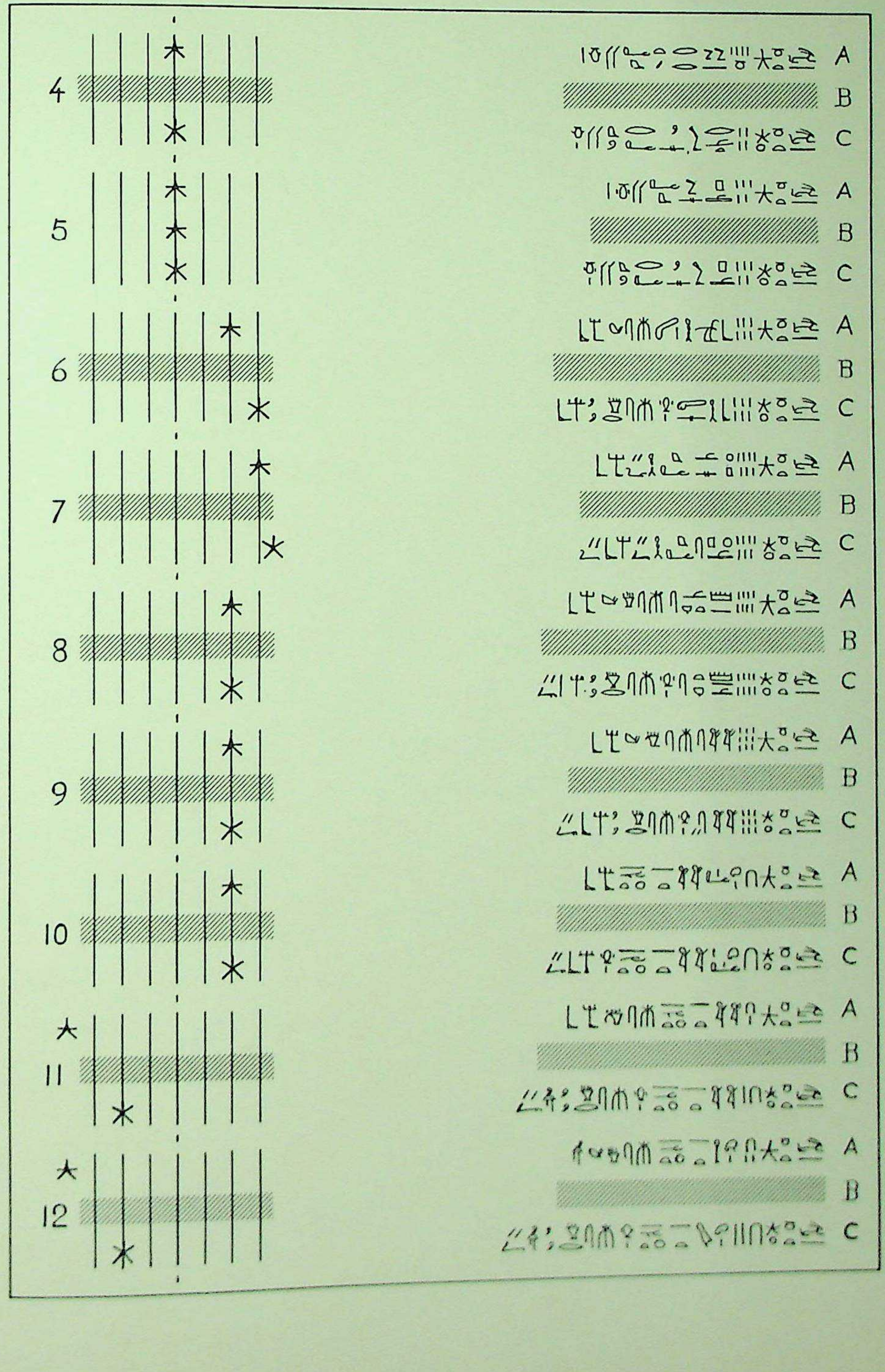
4
A
B
C
5
A
B
C
6
A
B
C
7
A
B
C
8
A
B
C
9
A
B
C
10
A
B
C
11
A
B
C
12
A
B
C

TABLE 18

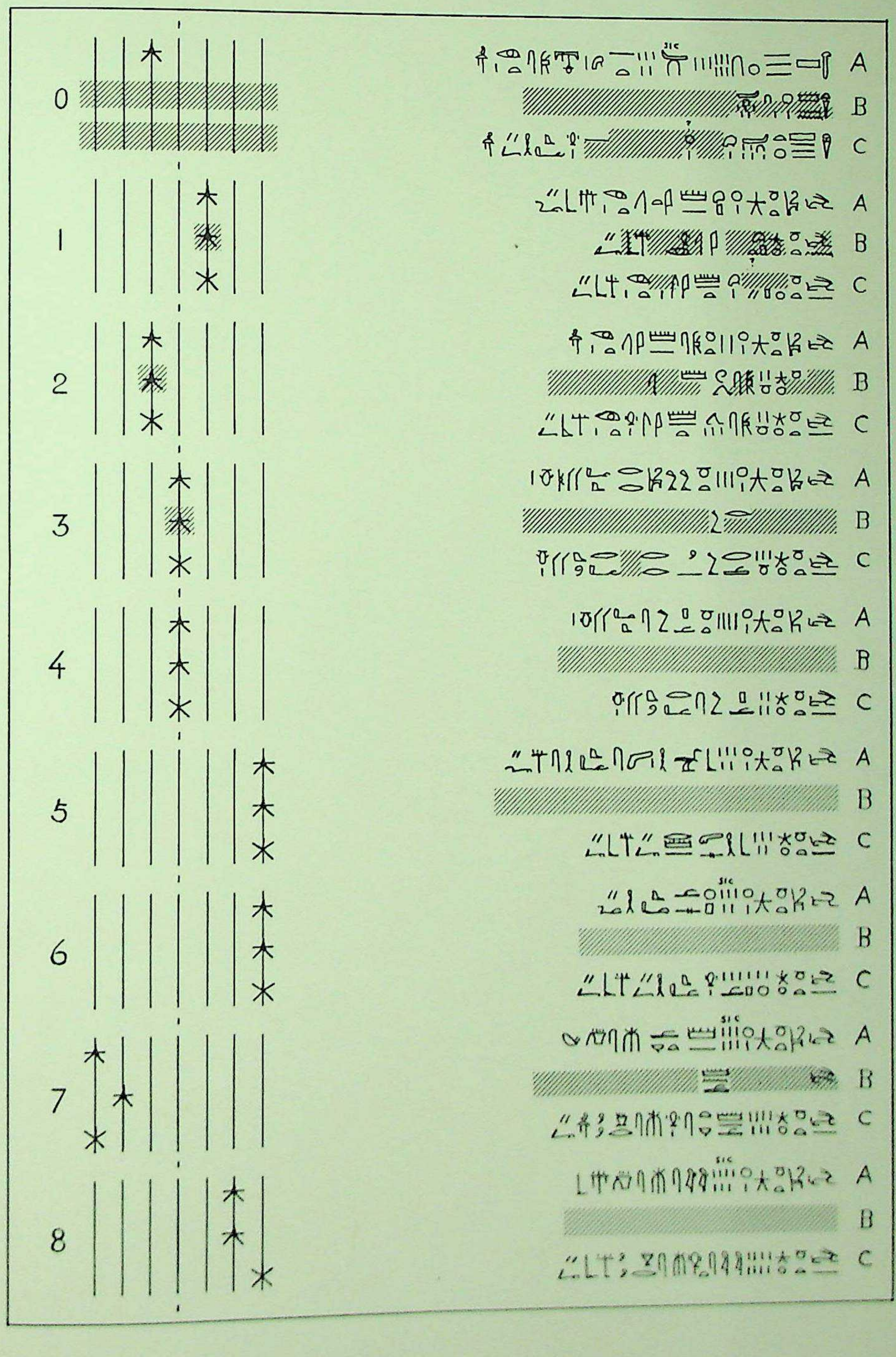
0
A
B
C
1
A
B
C
2
A
B
C
3
A
B
C
4
A
B
C
5
A
B
C
6
A
B
C
7
A
B
C
8
A
B
C
SIC
SIC
SIC
SIC

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TABLE 18

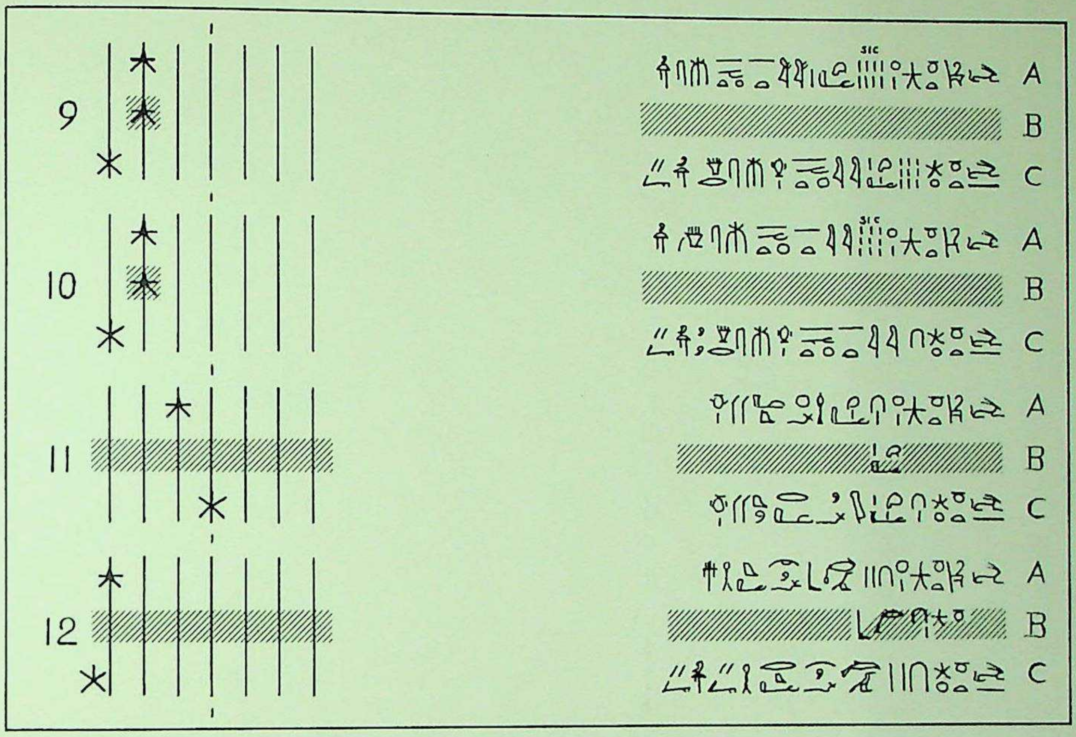

9
10
11
12
A
B
C
sic
sic

TABLE 19

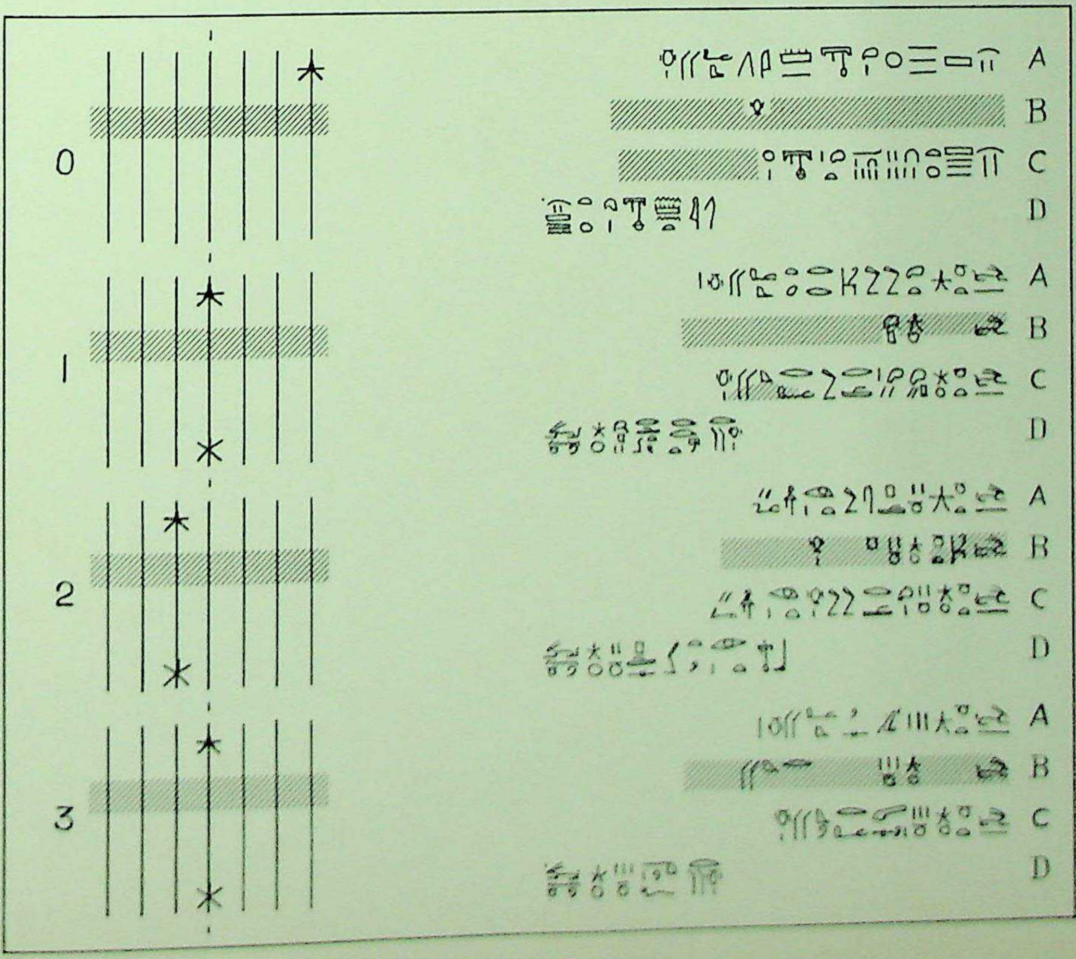


TABLE 19

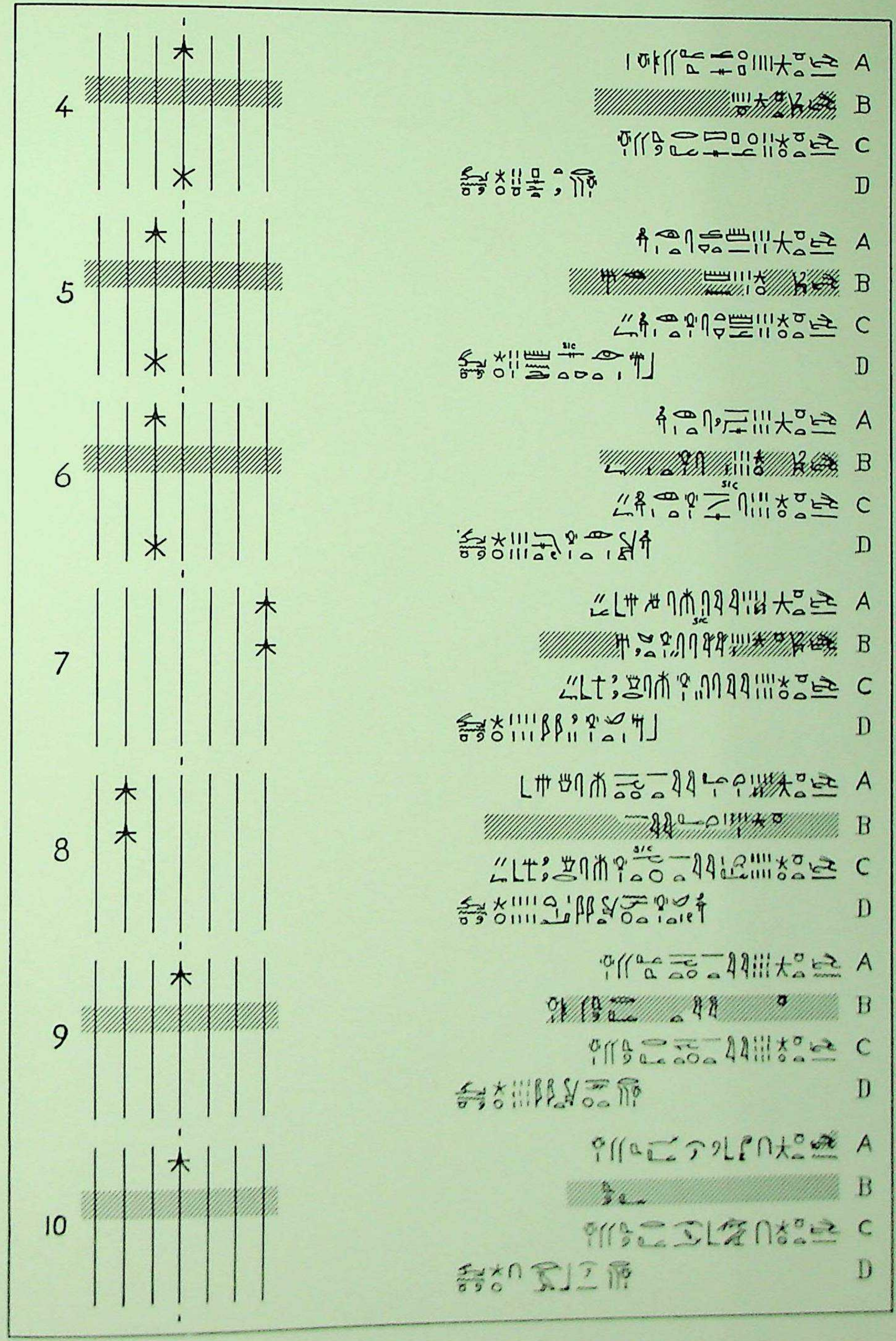

4
A
B
C
D
5
A
B
sic
C
D
6
A
B
sic
C
D
7
sic
A
B
C
D
8
A
B
sic
C
D
9
A
B
C
D
10
A
B
C
D

TABLE 19

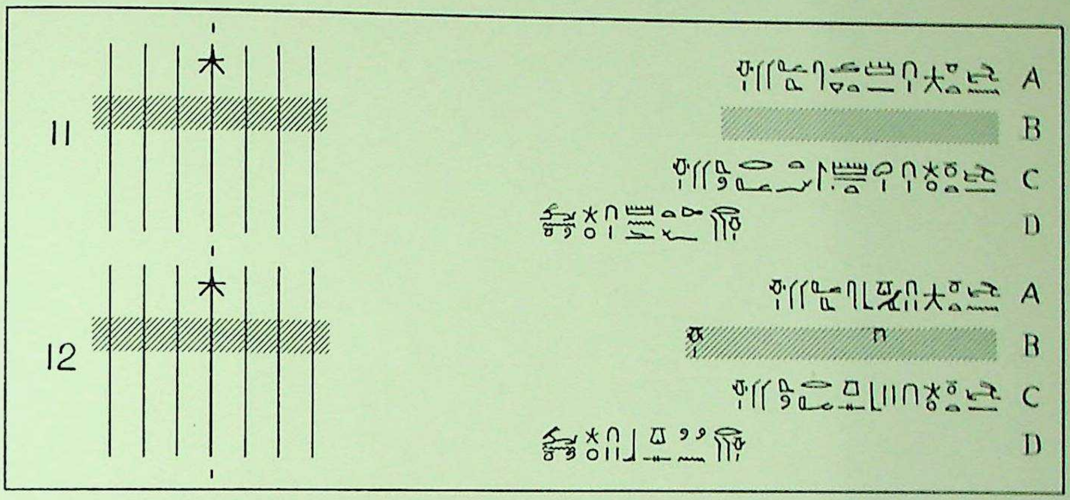

11
12
A
B
C
D
A
B
C
D

TABLE 20

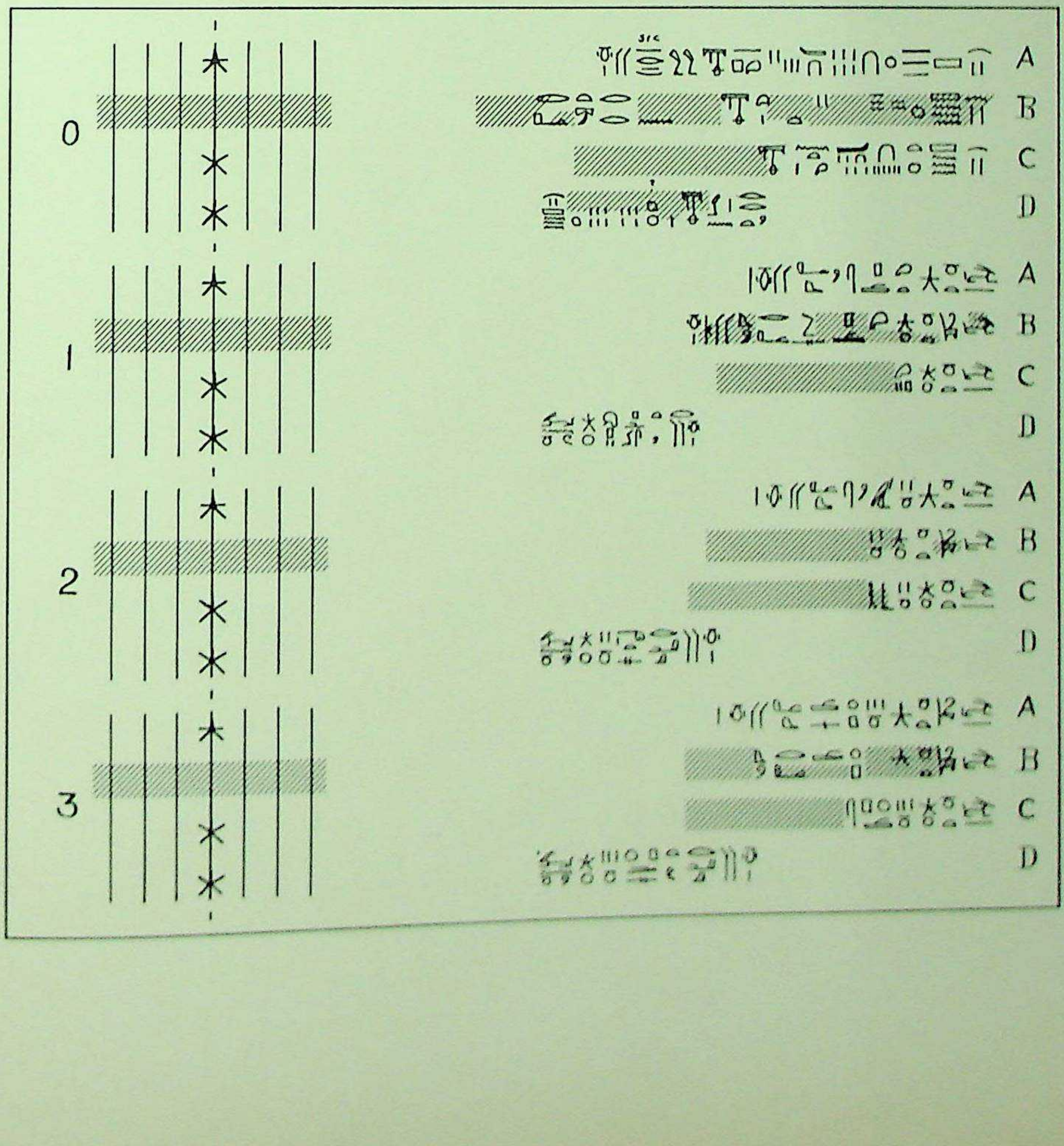
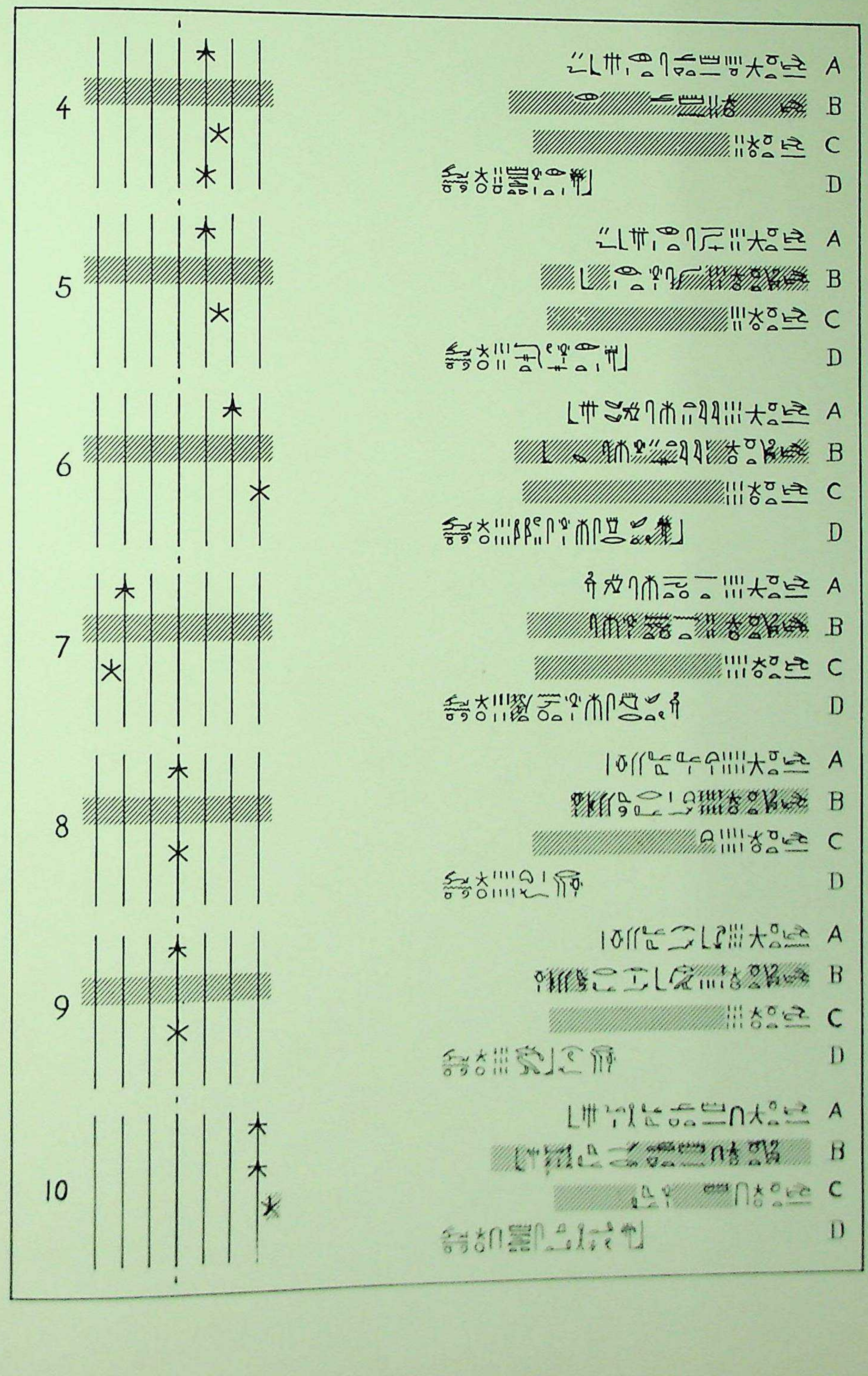

sic
0
1
2
3
A
B
C
D
A
B
C
D
A
B
C
D
A
B
C
D

TABLE 20



4
A
B
C
D
5
A
B
C
D
6
A
B
C
D
7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D

TABLE 20

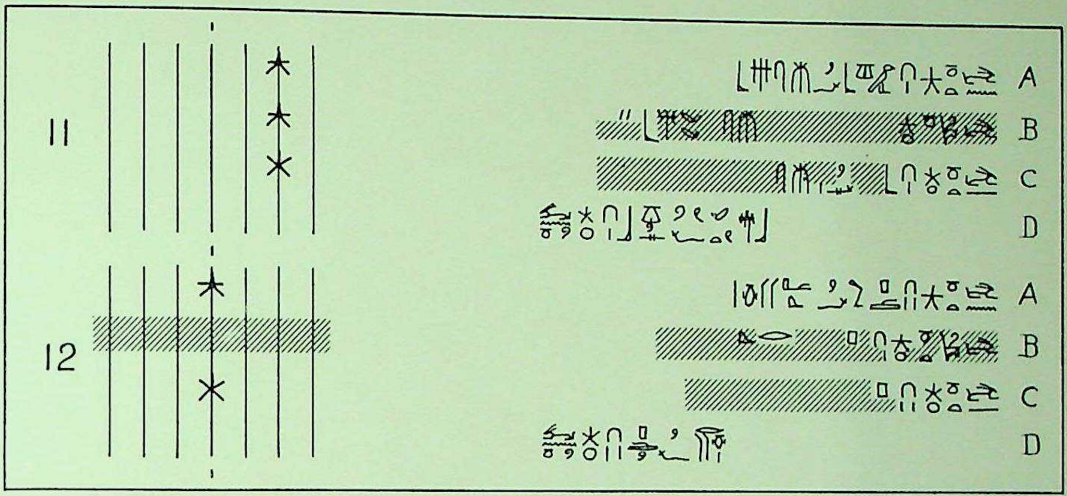

11
A
B
C
D
12
A
B
C
D

TABLE 21

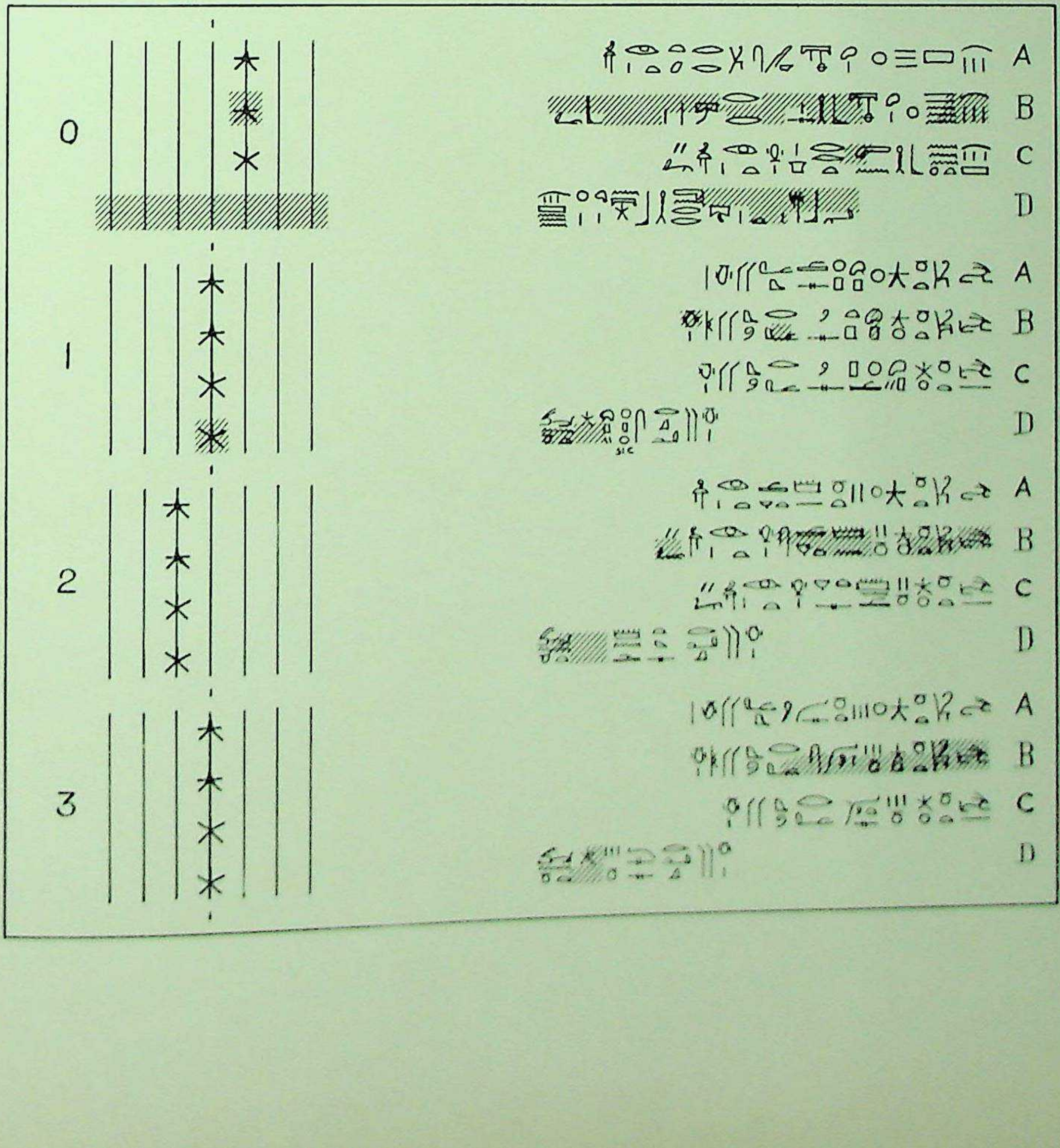

0
A
B
C
D
1
A
B
C
D
sic
2
A
B
C
D
3
A
B
C
D

TABLE 21

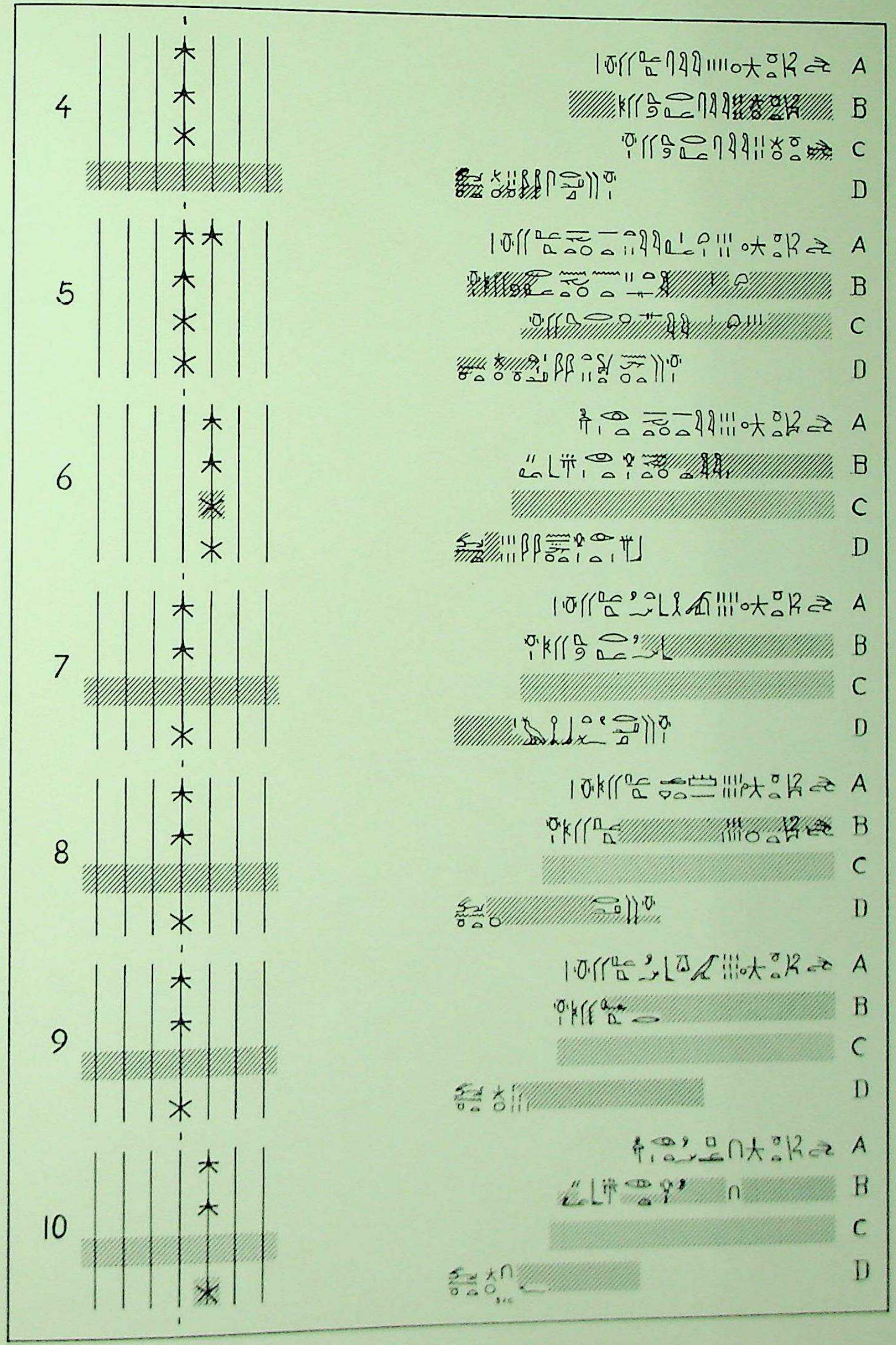

4
A
B
C
D
5
A
B
C
D
6
A
B
C
D
7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D
sic

TABLE 21

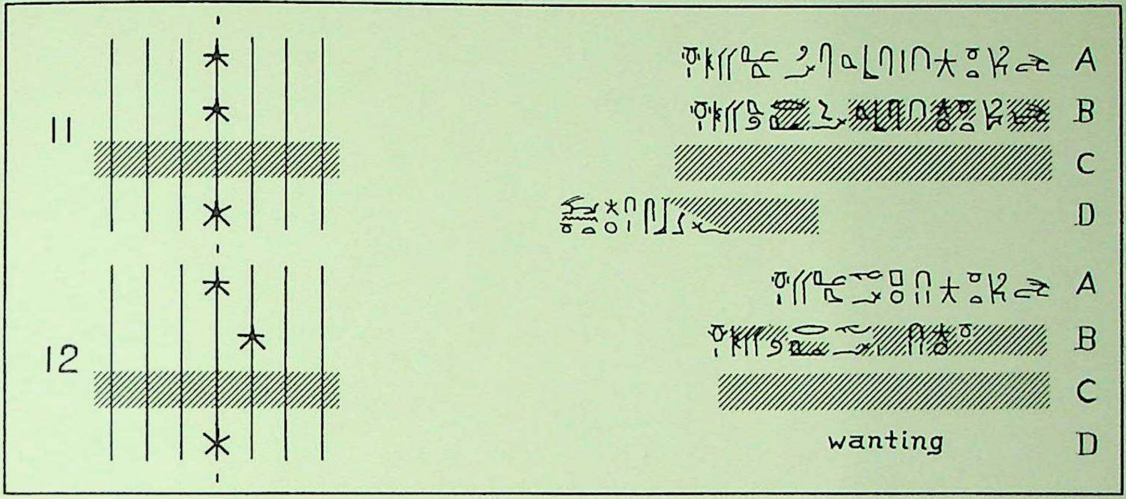

11
A
B
C
D
12
A
B
C
wanting
D

TABLE 22

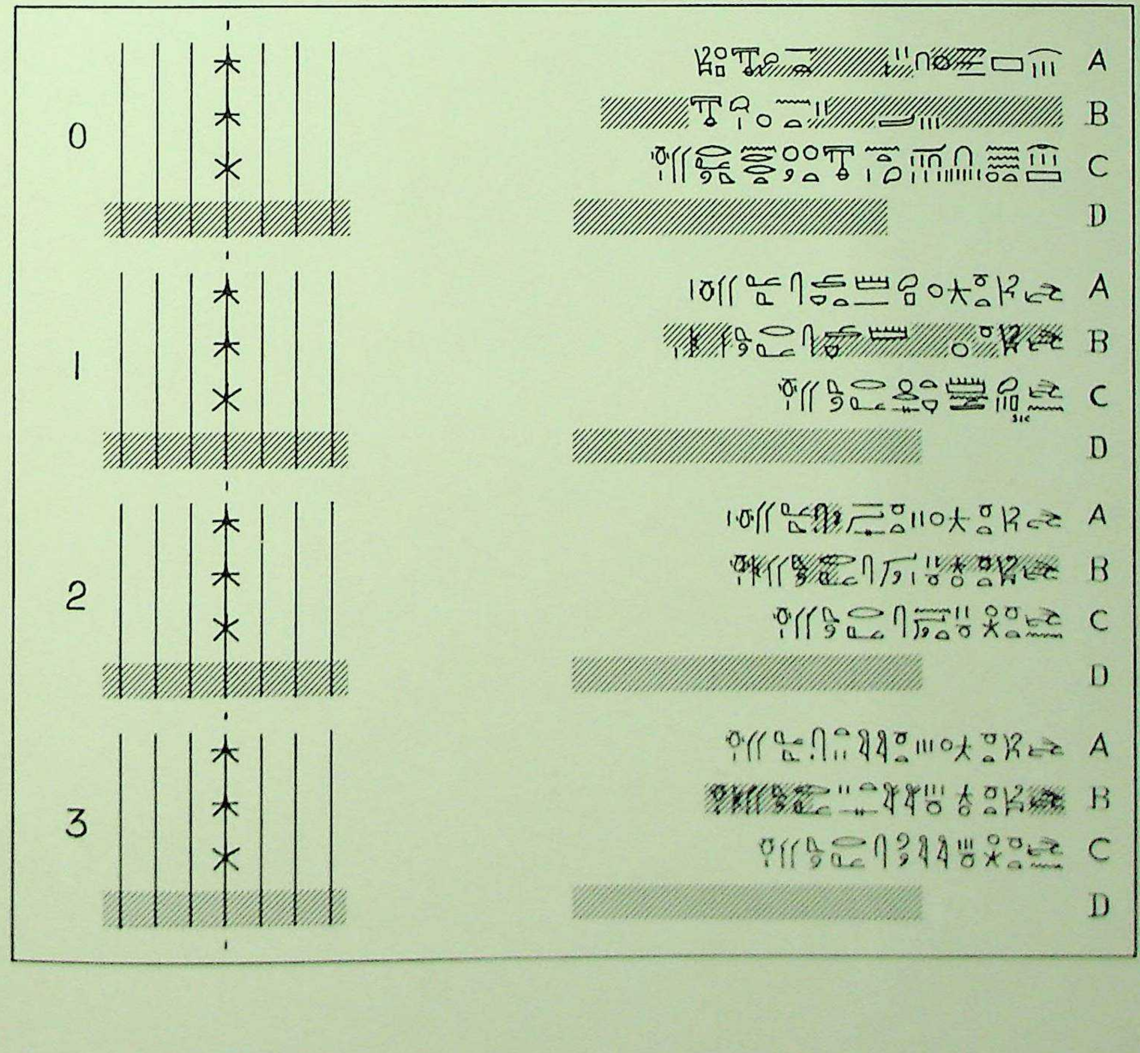

0
A
B
C
D
1
A
B
C
sic
D
2
A
B
C
D
3
A
B
C
D

TABLE 22

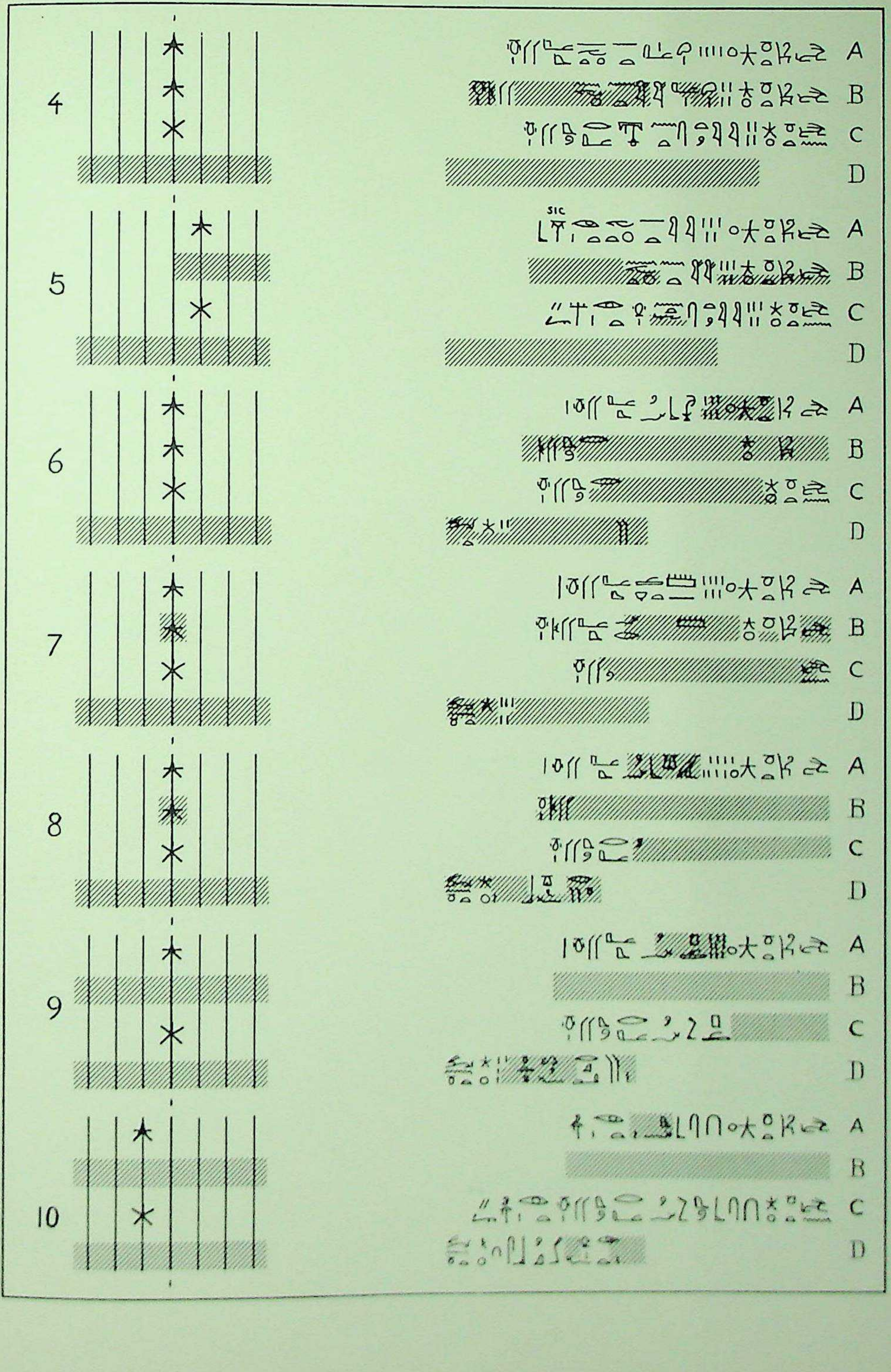

4
A
B
C
D
5
SIC
A
B
C
D
6
A
B
C
D
7
A
B
C
D
8
A
B
C
D
9
A
B
C
D
10
A
B
C
D

PLATE 65

TABLE 22

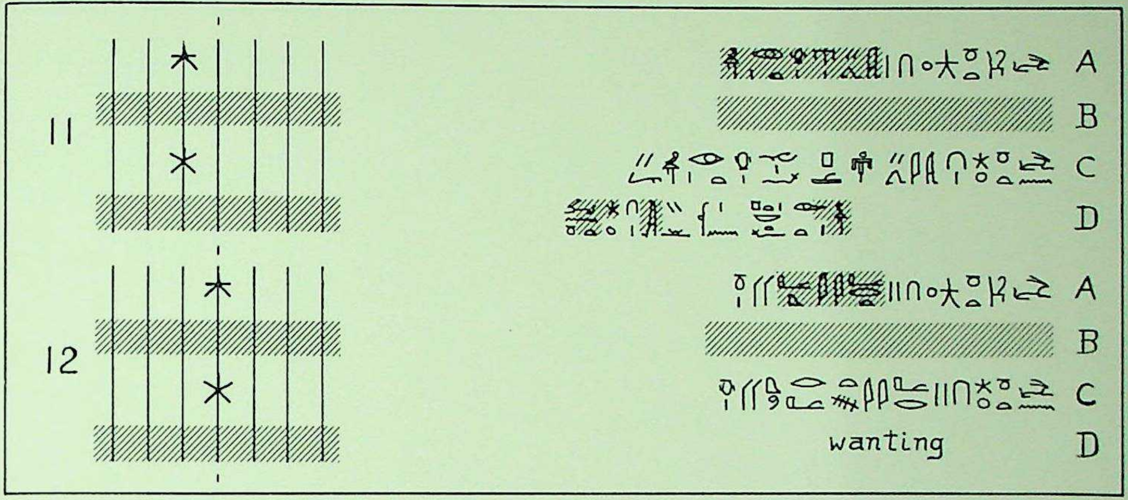

11
A
B
C
D
12
A
B
C
wanting
D

TABLE 23

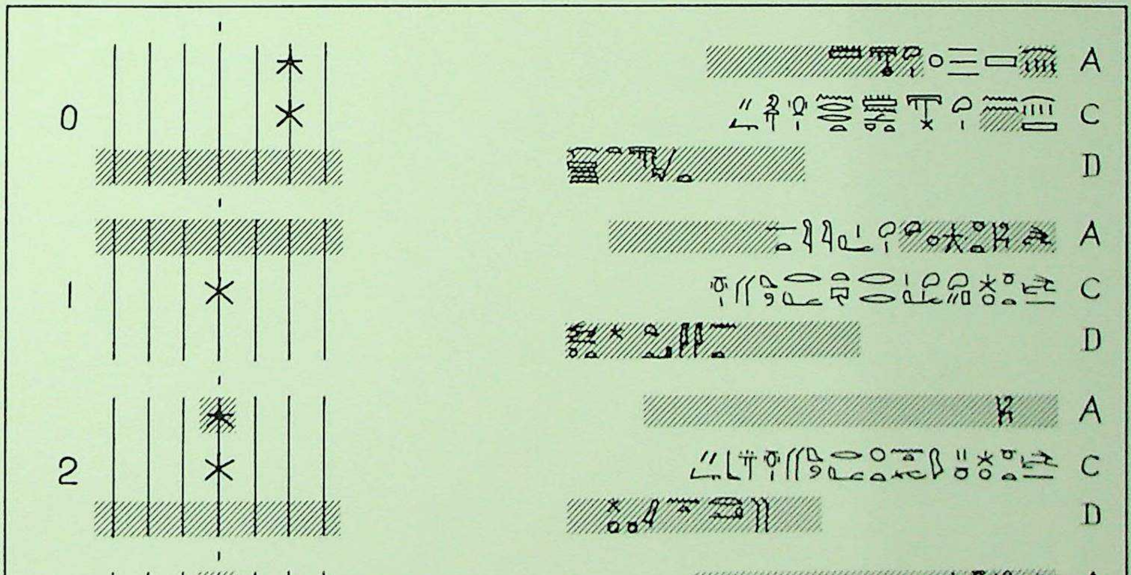

0
A
C
D
1
A
C
D
2
A
C
D
3
A
C
D
4
A
C
D

TABLE 23

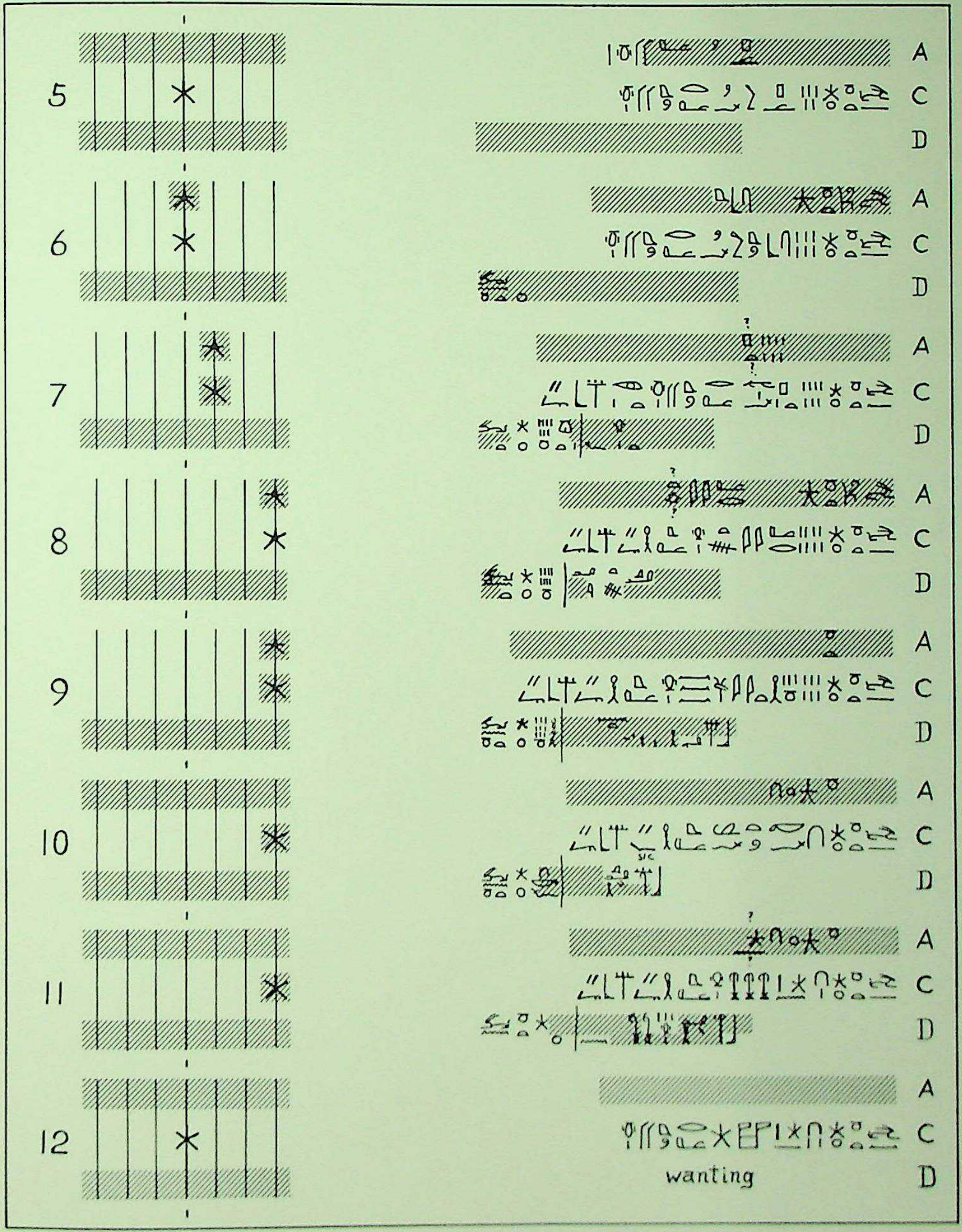
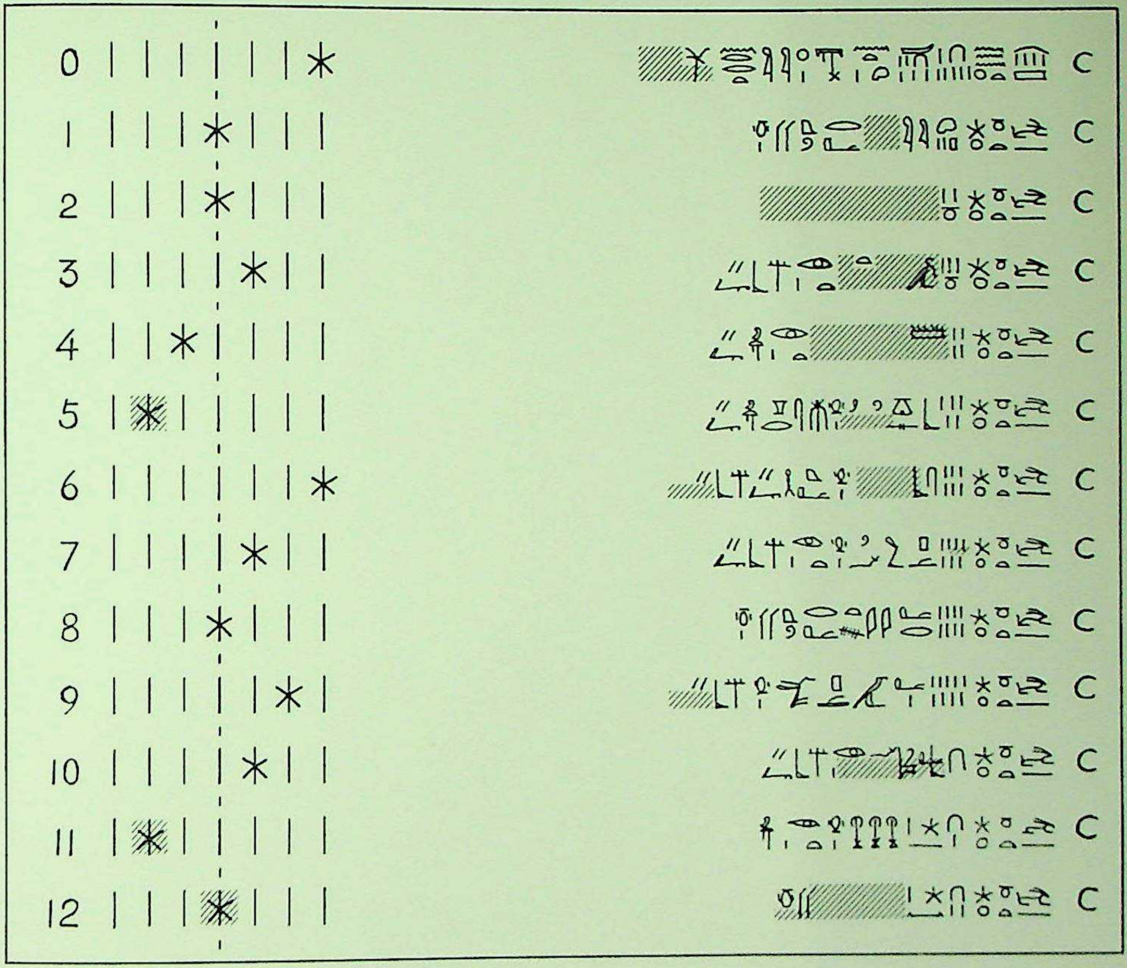

5
6
7
8
9
10
11
12
A
C
D
sic
wanting

TABLE 24


0
1
2
3
4
5
6
7
8
9
10
11
12
C

$20.